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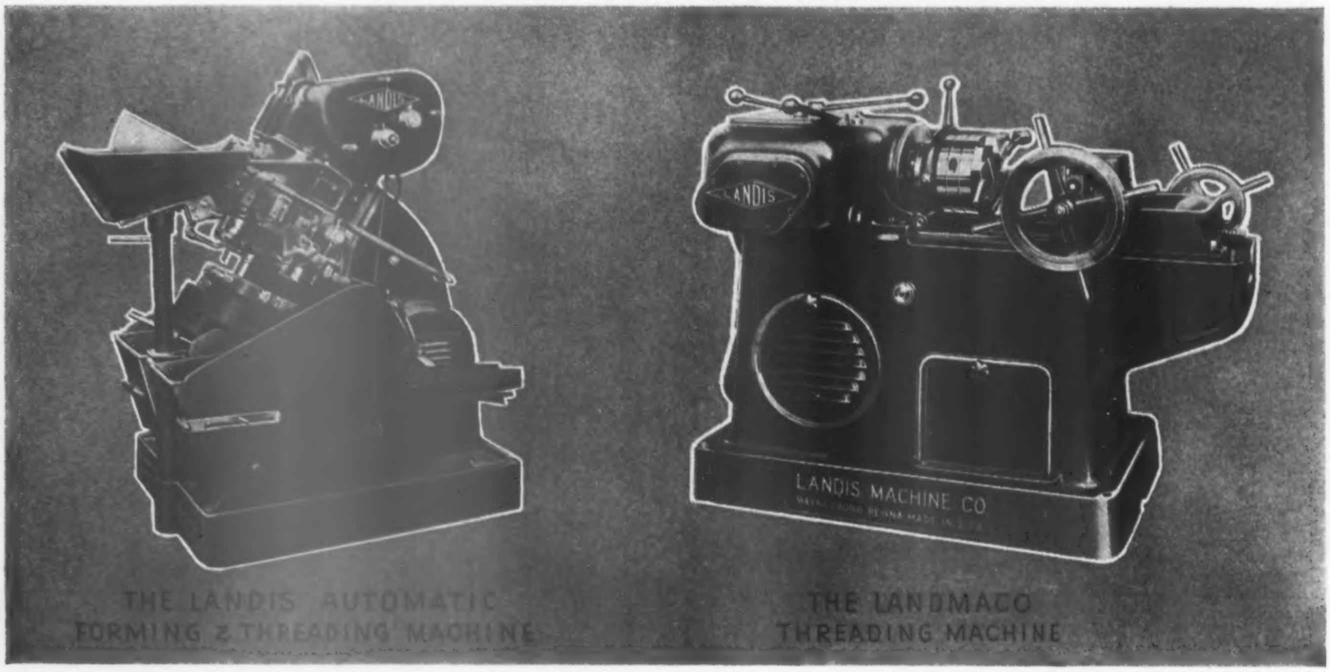

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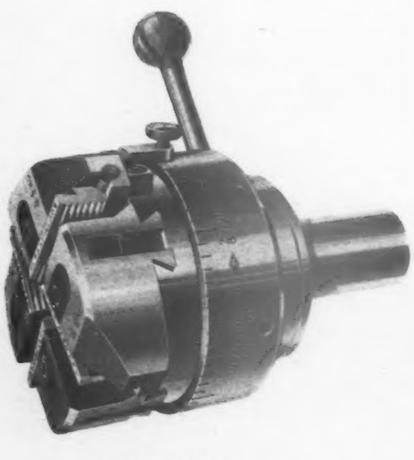
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Twelve Coal-Burning

2-8-8-4 Locomotives for S. P.

These locomotives, built by Lima, are similar in capacity to the oil-burning locomotives which operate cab ahead—They are in heavy passenger and freight service between El Paso Tex., and Tucumcari, N. M.

TWELVE articulated locomotives of the 2-8-8-4 type for passenger and freight service have been delivered by the Lima Locomotive Works, Inc., to the Southern Pacific. These locomotives are coal burners and have been given a particularly clean appearance by the use of the "skyline" casing over the top of the boiler and by a reinforced steel-plate pilot with decorative metal striping. They are in service on the Pacific Lines between El Paso, Tex., and Tucumcari, N. M. This line, which is 332 miles long, reaches a maximum elevation of 6,724 ft., with long ascents in both directions, with maximum grades of 1 per cent. Eastbound, from El Paso to the summit between Gallinas, N. M., and Corona, the line rises 3,000 ft. Westbound, between Tucumcari and the summit, the rise is 2,700 ft.

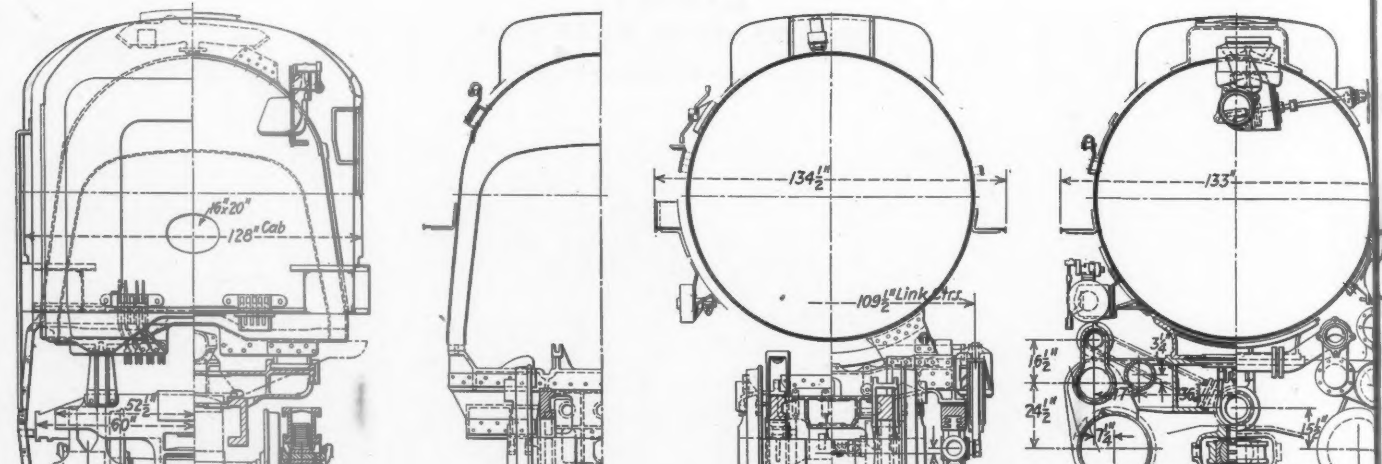
These locomotives are much the same in capacity and general construction as the locomotives of similar wheel arrangement which, since 1928, have been built in considerable numbers for oil-burning service on the Southern Pacific. The latter locomotives, however, have all been arranged for operation with the cab ahead. The boilers of the coal-burning locomotives, differing in detail dimensions from those of the oil-burning locomotives, are slightly larger. A feature of particular interest is the employment of crown-bearing driving boxes which have oil lubrication.

The locomotives have a total weight of 689,900 lb., of which 77 per cent is on the drivers, and develop a rated tractive force of 124,300 lb. The boiler carries a working pressure of 250 lb. per sq. in. The cylinders on each of the two engine units per locomotive are 24 in. bore by 32 in. stroke. The diameter of the driving wheels is 63½ in. The locomotives are designed for a maximum speed of 75 miles an hour and can negotiate curves up to a maximum of 18 deg. A maximum cylinder horsepower of 6,000 is developed at 40 m.p.h.

Frames and Running Gear

The foundation of each unit of the locomotive is a Commonwealth bed casting in which the cylinders are cast integral. The cylinder spread is 93 in. The second barrel course of the boiler is carried on the rear cylinder saddle. The front and intermediate furnace bearers are of the expansion plate type. The rear furnace bearers are oil-lubricated expansion shoes.

The hinged radius bar at the rear end of the front bed casting is pivoted about a 7-in. pin and ball joint which is pocketed in the rear cylinder saddle. The boiler bearing on the front unit is between the second and third pairs of drivers. The sliding pads are oil lu-



Elevation and cross-sections of the Southern Pacific Class AC-9 arti

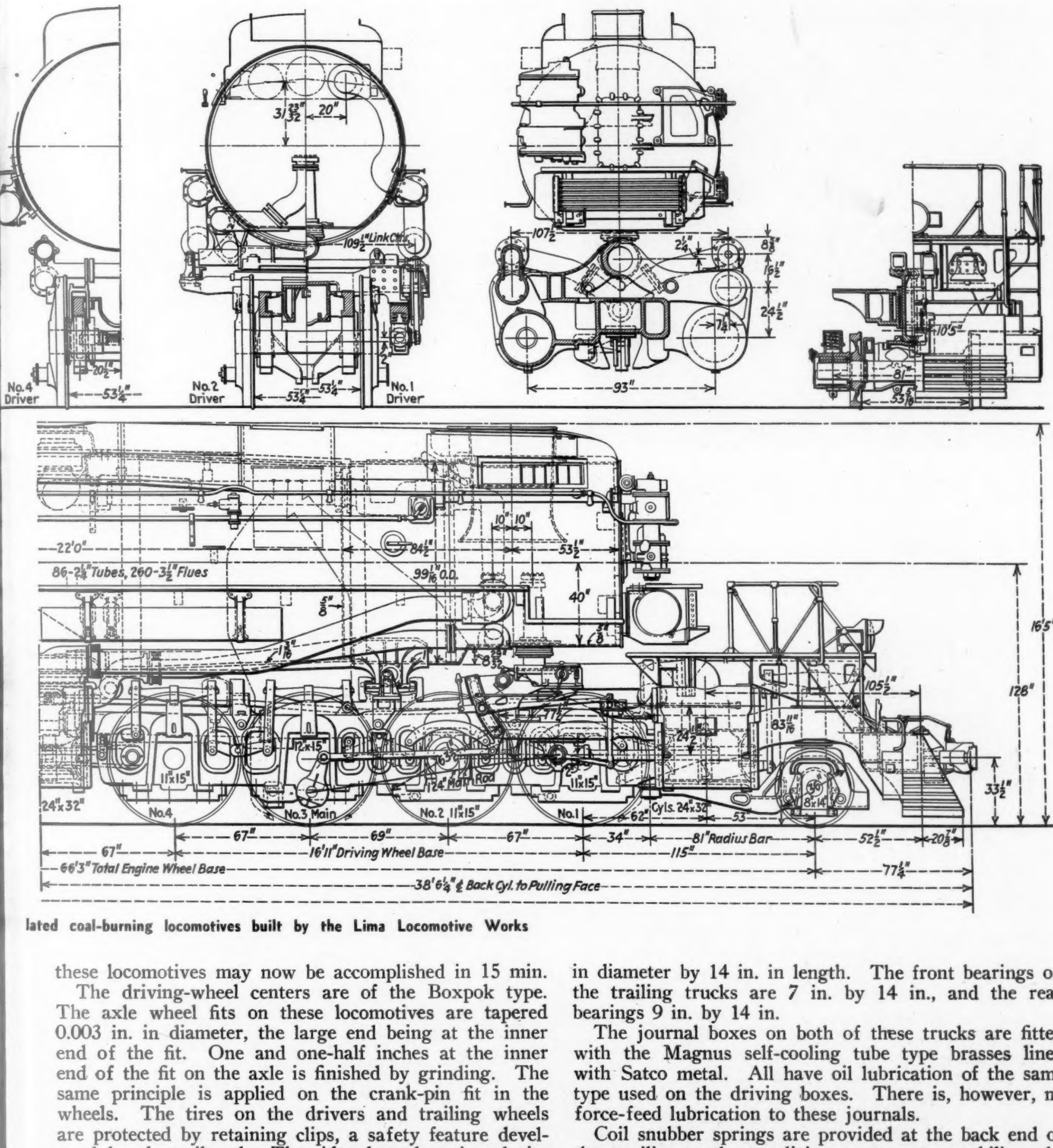
bricated and a spring centering device is part of the installation.

The driving-journal boxes are of the crown-bearing type, oil lubricated. Each driving box is provided with a spring-pad lubricator developed by the Southern Pacific which fits in the bottom of the journal-box cellar. The cellar is filled to the proper level with oil which is fed by means of cotton-string wicks to the lubricator pad that fits snugly against the bottom of the driving journal. A glass bulls-eye in the cellar shows the oil level. Supplementing the spring-pad lubrication, oil is also fed to the journals by a force-feed mechanical lubricator.

Inserted in the ends of the cellars adjoining the driving-wheel hubs are hard felt pads which project ⅛ in. beyond the Satco-lined face of the driving box. These pads are fed with oil from the cellar through small holes at the end of the cellar, thus providing positive automatic lubrication of the driving wheel hubs. The driving box cellars are held in place by latches fitted with coil springs to permit free endwise movement of the cellars when the lateral motion of the wheels causes the hub faces to come in contact with the felt pads. The cellars are easily withdrawn by sliding out the cellar endwise without removing the cellar bolts. Dirt, water, and other foreign matter is kept out of the cellars by means of serrated brass spring-action dust guards closely fitted to the top and bottom of the journals on the inside end and by a spring-action Corprene oil seal at the outside or hub end.

Because brass crown bearings do not provide a satisfactory bearing surface against steel when oil lubricated, a serrated recess is cut in the crown brass, into which is poured a lining of white metal as a bearing surface. This metal has the characteristic of maintaining an even distribution of oil over its entire surface and is soft enough so that scoring of the journals is substantially minimized should bearings become overheated for any reason. The composition of the white metal is 85 per cent tin, 10 per cent antimony, and 5 per cent copper. Satco metal is cast on the hub faces of the driving- and trailing-truck boxes.

The time required to repack the conventional grease cellars in 16 driving boxes on one of these locomotives was found to have been about 2 hrs. 40 min. The filling of 16 oil cellars in the driving boxes of one of



lated coal-burning locomotives built by the Lima Locomotive Works

these locomotives may now be accomplished in 15 min.

The driving-wheel centers are of the Boxpok type. The axle wheel fits on these locomotives are tapered 0.003 in. in diameter, the large end being at the inner end of the fit. One and one-half inches at the inner end of the fit on the axle is finished by grinding. The same principle is applied on the crank-pin fit in the wheels. The tires on the drivers and trailing wheels are protected by retaining clips, a safety feature developed by the railroad. The Alco lateral-motion device is applied on the rear pair of driving wheels on the front unit and on the front pair of driving wheels on the rear unit.

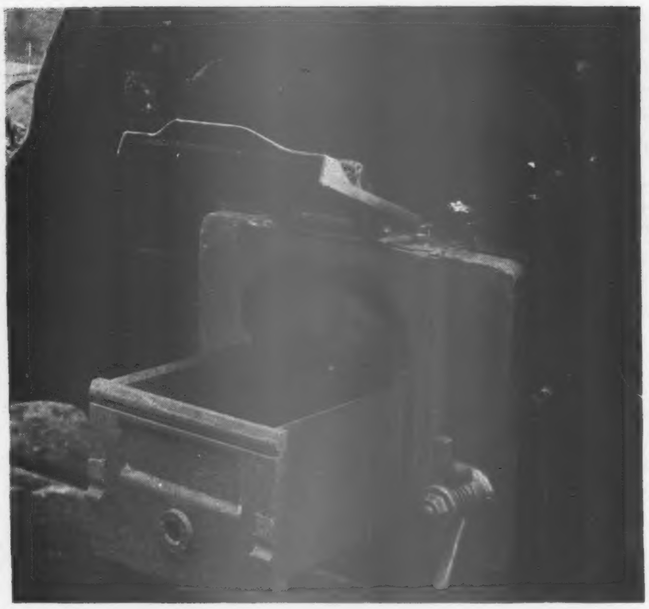
The leading truck is of the two-wheel type with a constant-resistance lateral motion of 33½ per cent. The trailing truck is of the four-wheel Delta type. The initial lateral resistance is 15 per cent with a constant-resistance of 10 per cent. Both trucks are furnished by the General Steel Castings Corporation. The leading truck wheels are of wrought steel, 36 in. in diameter. All four trailing-truck wheels have cast-steel spoke centers and are 45½ in. in diameter over the tires. The engine-truck journal bearings are 8 in. in diameter by 14 in. in length. The front bearings on the trailing trucks are 7 in. by 14 in., and the rear bearings 9 in. by 14 in.

The journal boxes on both of these trucks are fitted with the Magnus self-cooling tube type brasses lined with Satco metal. All have oil lubrication of the same type used on the driving boxes. There is, however, no force-feed lubrication to these journals.

Coil snubber springs are provided at the back end of the trailing-truck equalizing system to stabilize the rigging.

These locomotives have 40 per cent of the reciprocating parts balanced, the main wheels being cross-balanced. The balances in the front, intermediate, and back wheels are increased to allow for cross-balance effects, the overbalancing thus gained being deducted from the main wheels. The main rods were pendulum tested to determine the correct revolving effect.

The driving tires, as well as the tender wheels, are cooled with an air-controlled water system developed by the Southern Pacific. This wheel-cooling system operates automatically whenever the brakes are applied. It consists of an outlet from the water tank, operated



Trailing-truck journal box showing how the oil cellar is removed—The same type of oil lubrication is applied to the driving boxes

by an air-controlled valve with longitudinal pipes and lateral branches at each wheel, terminating in spraying nozzles. Whenever the engineman applies the brakes, he also opens the control valve of the wheel-cooling system, thus causing a sufficient amount of water to flow on the wheels to counteract the heating effect of the brake shoes. A cock conveniently located in the cab permits the engineman to cut out the cooling system when it is not needed.

The Boilers

The boilers of these locomotives are of the conical type, the taper being in the first course. The shell sheets, which are of basic open-hearth flange steel, are $1\frac{3}{16}$ in. thick in the first and second courses and $1\frac{7}{32}$ in. thick in the third course. The combustion chamber extends into the third barrel course and is 58½ in. long. The length over the tube sheets is 22 feet.

The firebox, which measures nearly 206 in. in length inside the mud ring, is of acid open-hearth steel. It is of welded construction, with the exception of the tube sheet which is riveted in the combustion chamber. The sheets are also welded at the mud-ring corners. The longitudinal seams in the barrel courses are seal welded at the ends for a distance of about 14 in. In the firebox are seven Security circulators.

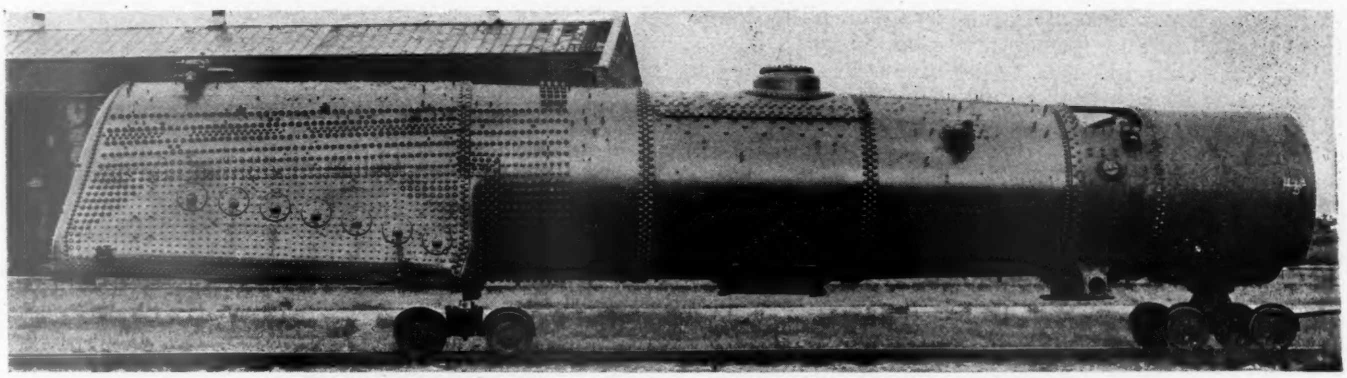
Six Nathan boiler drop plugs are placed in the crown sheet of the combustion chamber to prevent boiler explosions caused by overheating due to low water. One each is installed near the front and rear of the combustion chamber on the top longitudinal center line with two pairs placed at intermediate points, each pair spaced four rows apart on either side of the center line. The reliability and effectiveness of a multiple application of drop plugs has been demonstrated beyond question in actual service since its adoption as standard on all locomotives operated by the Southern Pacific.

Flannery Type D tell-tale flexible staybolts with UW type sleeves and caps are used in the breaking zones in the sides and back of the firebox. There is a full installation of these bolts in the combustion chamber, except for the long stays over the crown sheets. Expansion crown stays are applied on the four front transverse rows over the top of the combustion chamber. These are the Flannery Type K with WR sleeves.

The grates are the Firebar type with 21 per cent air openings, and coal is fed by a Standard type MB stoker, with the engine located in a pocket on the left side of the tender. The locomotives burn a low grade bituminous coal from the Dawson field in New Mexico. It has a heating value of approximately 12,000 B.t.u. per pound.

General Dimensions, Weights and Proportions of the Southern Pacific 2-8-8-4 Type Locomotive

Railroad	Southern Pacific
Builder	Lima Locomotive Works, Inc.
Type of locomotive	2-8-8-4
Road class	3800-3811
Road numbers	AC-9
Date built	1939
Service	Freight and passenger
Dimensions:	
Height to top of stack, ft.-in.	16-3 $\frac{1}{32}$
Height to center of boiler, ft.-in.	10-8
Width overall, in.	134½
Cylinder centers, in.	93
Weights in working order, lb.:	
On drivers:	
Front	265,500
Back	265,700
Total	531,200
Engine truck	48,300
Front trailer axle	48,900
Rear trailer axle	61,500
Total engine	689,900
Tender	400,700
Wheel bases, ft.-in.:	
Driving (each unit)	16-11
Rigid (each unit)	11-4
Engine, total	66-3
Engine and tender, total	112-11⅞
Wheels, diameter outside tires, in.:	
Driving	63½
Front truck	36
Trailing truck	45½
Engine:	
Cylinders, number, diameter and stroke, in.	4-24x32
Valve gear, type	Walschaert
Valves, piston type, size, in.	11
Maximum travel, in.	6½
Steam lap, in.	$1\frac{5}{16}$
Exhaust clearance	Line and line
Lead, in.	$\frac{3}{16}$
Cut-off in full gear, per cent	81
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	250
Diameter, first ring outside, in.	$97\frac{7}{16}$
Diameter, largest, outside, in.	109⅛
Firebox length, in.	$205\frac{21}{32}$
Firebox width, in.	102¼
Combustion chamber length, in.	58½
Tubes, number and diameter, in.	86—2¼
Flues, number and diameter, in.	260—3½
Length over tube sheets, ft.-in.	22—0
Net gas area through tubes and flues, sq. ft.	12.60
Fuel	Soft coal
Grate area, sq. ft.	139.3
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	465
Circulator	124
Firebox, total	589
Tubes and flues	6,329
Evaporative, total	6,918
Superheater	2,831
Combined evap. and superheat.	9,749
Tender:	
Type	Rectangular
Water capacity, gal.	22,120
Fuel capacity, tons	28
Trucks	6-wheel
Rated tractive force, engine, lb.	124,300
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	77.00
Weight on drivers ÷ tractive force	4.27
Weight of engine ÷ evap. htg. surface	99.7
Weight of engine ÷ comb. htg. surface	70.77
Boiler proportions:	
Firebox htg. surface, per cent comb. htg. surface	6.04
Tube-flue htg. surface, per cent comb. htg. surface	64.92
Superheater htg. surface per cent comb. htg. surface	29.04
Firebox htg. surface ÷ grate area	4.23
Tube-flue htg. surface ÷ grate area	45.43
Superheater htg. surface ÷ grate area	20.32
Comb. htg. surface ÷ grate area	70.0
Gas area, tubes-flues ÷ grate area	.090
Evap. htg. surface ÷ grate area	49.66
Tractive force ÷ grate area	892.3
Tractive force ÷ evap. htg. surface	17.97
Tractive force ÷ comb. htg. surface	12.75
Tractive force × dia. drivers ÷ comb. htg. surface	809.6



The boiler is supported by sliding shoes under the rear end of the firebox, by expansion plate under the front end of the firebox, by the rear cylinder saddle under the middle barrel course, and by sliding pad under the rear of the smokebox

The boiler feed equipment comprises a Hancock turbo feedwater heater, size TA-2, mounted below the cab on the left side of the locomotive, which is capable of delivering to the boiler 13,000 gallons of water per hour. Supplementing the feedwater heater is a Nathan No. 17 Simplex injector with a rating of 12,000 gallons per hour. The Signal Foam-Meter and Electro-Pneumatic blow-off are part of the boiler equipment.

The superheater is a Type E with the American multiple throttle built into the header. Steam enters the drypipe through a Tangential steam dryer in the dome.

The ash pans are designed with an air opening equal to the total flue cross-sectional area. In addition to the two hoppers inside the frames, there is an outside hopper at the front of the ash pan on either side of the locomotive.

Steam Distribution

Steam for both engines leaves the front-end branch pipes through a single pair of outside steam pipes, one on each side of the locomotive. Each of these pipes, which are 9 in. in diameter, is carried back from the elbow casting at the side of the smokebox to the front of the rear cylinders where there is a slip-joint connection. Live steam for the front pair of cylinders is carried forward from the front face of the rear saddle casting by a single 8-in. pipe on the longitudinal center line of the locomotive. This pipe is in two sections with ball and slip joints between the sections and a ball joint at the back hinge connection. The connection between the sections is made in a chamber in the bed casting. The steam pipes are insulated with special Insubestos covering.

Exhaust pipes from the rear cylinders extend forward along each side of the locomotive toward the smokebox. These are 8-in. pipes with slip joints between the pipes and cast-steel extensions from the cylinders. These extensions are cross-connected to supply steam to the turbo feedwater heater. At the smokebox end, the exhaust-pipe flange is bolted to a smokebox elbow connection leading to the rear of two exhaust pipes. The flexible exhaust pipe from the front cylinders is made up of two sections of cast-iron pipe which are joined by a long slip joint. The front section is fastened to the cylinder-saddle casting by a ball joint, and the elbow at the rear end of the rear section has a ball seat in a spring casing attached to a bolting flange at the bottom of the smokebox. This forms the base of the forward exhaust stand. The exhaust pipes are not lagged.

The driving-box spring-pad lubricator used on the Southern Pacific locomotives

Steam distribution is effected by Walschaert valve motion which drives 11-in. valves with a maximum travel of 6½ in. The power reverse gear is an Alco type H. The valves are fitted with Hunt-Spiller gun-iron bull rings and Duplex sectional packing rings. The valve-chamber bushings are also of Hunt-Spiller gun iron.

The Driving Gear

The main driving wheels are the third pair in each engine unit. The side rods have fixed bronze crank-pin bearings on the first and fourth pairs of driving wheels and floating bushings on the main and intermediate crank pins. The floating bronze bushings run in Hunt-Spiller gun-iron fixed bushings. The back end of the main rod also has a floating-bushing bearing. Bronze wear plates are set in the faces of the main and intermediate driving wheels around the crank pins on both engine units to prevent wear of the ends of the fixed rod bushings.

The guides and crossheads are of the multiple-bearing type. The crossheads are cast steel and bronze rings inside prevent galling of the front end of the main rod. The pistons are the Locomotive Finished Material Company's lightweight alloy-steel type with combination bronze and iron packing rings.

The main and side rods, the driving axles, engine and trailer-truck axles, crank pins, wrist pins, knuckle pins, combination lever, union link, and radius-bar lifter are all of medium carbon steel normalized and drawn. The driving axles are hollow bored to a diameter of 3 in. The valve-motion eccentric crank is also of medium carbon steel while the eccentric rod and link cheeks are of mild carbon steel. The link blocks are of mild steel, casehardened. Carbon-vanadium steel is used in the main and valve-stem crosshead keys. The guides are medium carbon steel, annealed.

Lubrication

There are four force-feed mechanical lubricators on

each locomotive. Two are for journal-box oil and two for valve oil. The former are each 36-pint Nathan DV-7 type, with 13 feeds. One of these is placed on the left side of each engine unit where it can be driven from the link of the valve motion. Eight feeds from each of these lubricators are used for driving-box journal lubrication, one feed leading to each driving box on the unit. Each of four feeds leads to a Nathan four-way oil distributor which serves the shoe and wedge faces for each pair of driving boxes. One feed, through a four-way distributor, lubricates the valve-rod crosshead guides. Texayce all-year car oil, conforming to Southern Pacific specifications, is used in these lubricators and in the cellars of all driving, engine-, trailer- and tender-truck boxes for journal lubrication.

A 20-pint Nathan DV-4 eight-feed mechanical lubricator is mounted on the right side of each engine unit. Feeds from these lubricators lead to the cylinders and steam chests. There are two feeds for the top of each main guide.

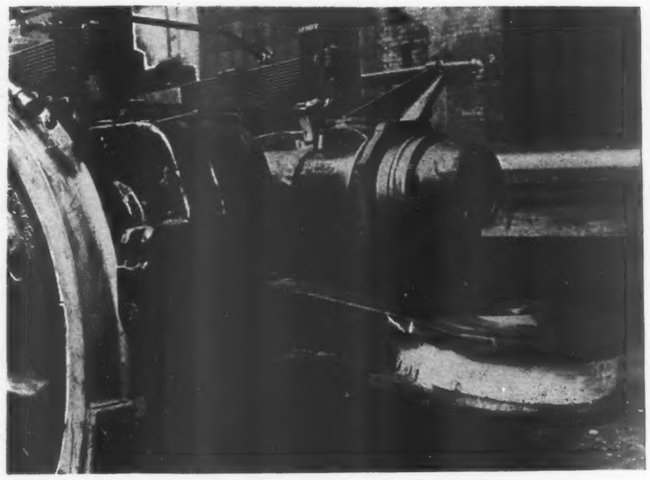
Fittings for Alemite lubrication are applied on the power reverse gear, the radial buffer, the side-rod knuckle pins, and the valve-motion parts. All crank pins and the eccentric-crank pins and rods are internally pressure-grease lubricated, and the rod ends are forged without grease cavities.

Cab and Cab Equipment

The steel cab is vestibuled and insulated below the windows. On six of the locomotives the insulation is 2 in. of Fiberglass and on the other six, Hairinsul. The cab windows are closed with Plexite non-shatter glass about 9/16 in. thick in the front windows and 3/8 in. thick in the sides and back. There is a seat and window for the head brakeman at the rear of the cab on the left side. All three cab seats have Dunlopillo sponge-rubber cushions and back rests.

There is a combination cab turret for both superheated and saturated steam. The superheated-steam section of the turret serves the blower, the stoker, the stoker engine, the stoker jets, and the soot blower. An auxiliary turret on the left side of the smokebox, through which the cab turret is supplied, also supplies superheated steam for the air compressors and the steam whistle. There is an air horn in addition to the steam whistle.

The air-brake equipment is Westinghouse No. 8ET.



The rear end of the front bed casting and running gear—In the foreground are the radius bar and the ball joint on the rear end of the steam pipe to the front cylinders

Two 8½-in. cross-compound air compressors are mounted on the smokebox front. A Westinghouse air intercooler is placed ahead of the smokebox.

These locomotives are equipped with both the Valve Pilot and steamchest and back-pressure gages operating on the rear engine only.

The Tender

The tender has a fuel and water capacity of 28 tons and 22,120 gallons, respectively. It is built up on a General Steel Castings water-bottom underframe. The tank sheets are welded to the underframe at the bottom. The remainder of the structure, however, is fabricated by riveting. In the coal space is a Standard type DA coal pusher.

The tender tank is of riveted construction

The two Buckeye six-wheel trucks are carried on 36-in. wrought-steel wheels with journals 7 in. in diameter by 14 in. long. The journal boxes are equipped with the Magnus self-cooling tube-type brasses lined with Satco metal, and the cellars are fitted with spring-pad lubricators similar to those in the locomotive driving and truck boxes. The wheel base of the trucks is 10 ft. The A. S. F. clasp brakes are operated by two 16-in. body-mounted cylinders. The engine and tender coupl-

ing includes the unit draw and safety bars and Franklin E-2 type buffer.

The boiler jacket, the skyline casing, the outside of the cab, except the roof, and the outside of the tender are finished in lacquer.

The principal dimensions and data are shown in one of the tables.

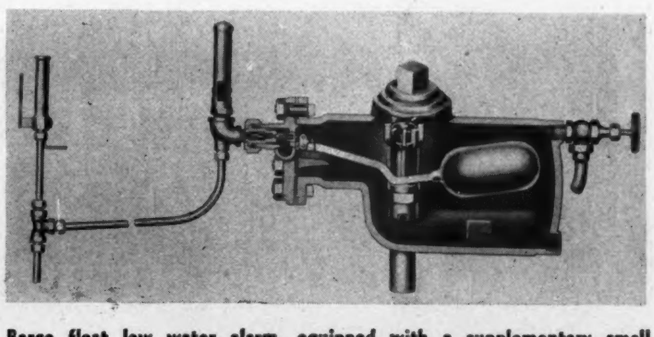
Partial List of Materials and Equipment on the Southern Pacific 2-8-8-4 Type Locomotive Built by Lima Locomotive Works

Bed castings; engine and trailer trucks	General Steel Castings Corp., Eddystone, Pa.
Axles, engine-truck wheels, tires, main crank pins	Standard Steel Works Co., Burnham, Pa.
Driving-wheel centers (Box-pok); trailing-wheel centers; crossheads; cylinder heads; driving boxes; smokestack	Ohio Steel Foundry Co., Lima, Ohio
Driving and truck-box bearings; bronze shoes and wedges	Magnus Metal Div., National Lead Co., New York
Tire retaining clips	Southern Pacific
Springs	American Locomotive Co., Railway Steel Spring Div., New York
Lateral motion device	American Locomotive Co., New York
Coupler and front draw casting	National Malleable and Steel Castings Co., Cleveland, Ohio
Journal-box lids, engine-truck and trailer	The Symington-Gould Corp., Rochester, N. Y.
Spring type radial buffer	Franklin Railway Supply Co., Inc., New York
Air-brake equipment	Westinghouse Air Brake Co., Wilmerding, Pa.
Driver brake shoes	American Brake Shoe & Foundry Co., New York
Foundation brake	American Brake Co., St. Louis, Mo.
Force-feed lubricators; hydrostatic lubricators	Nathan Manufacturing Co., New York
Hose, chassis lubrication	The DeVilbiss Company, Toledo, Ohio
Lubrication, soft grease	The Prime Manufacturing Co., Milwaukee, Wis.
Copper tubing	Phelps Dodge Copper Products Corp., New York
Flexible conduit on force-feed lubricator steam line	Barco Manufacturing Co., Chicago
Guides and piston-rod steel	Pittsburgh Crucible Steel Co., Pittsburgh, Pa.
Pistons	Locomotive Finished Material Co., Atchison, Kan.
Rod packing	Paxton-Mitchell Co., Omaha, Neb.
Valve bull rings; piston-valve bushings; rod bushings; Duplex sectional valve packing rings and springs	Hunt-Spiller Manufacturing Corporation, Boston, Mass.
Reverse gear	American Locomotive Co., New York
Staybolts, tell-tale flexible	Flannery Bolt Co., Bridgeville, Pa.
Rivets	The Champion Rivet Co., Cleveland, Ohio
Spring washers	National Lock Washer Co., Newark, N. J.
Staybolt iron	Ulster Iron Works, Dover, N. J.
Circulator units; firebrick	American Arch Co., Inc., New York
Circulator plugs	Huron Mfg. Co., Detroit, Mich.
Cylinder cocks	Southern Pacific Co.
Cylinder drain valves; smokebox front hinges	The Okadee Company, Chicago
Superheater; Tangential steam dryer; pyrometer	The Superheater Company, New York
Throttle, front-end multiple	American Throttle Co., New York
Smokebox netting	John A. Roebling's Sons Co., Trenton, N. J.
Tubes and flues (10)	Jones & Laughlin Steel Corp., Pittsburgh, Pa.
(2)	Pittsburgh Steel Co., Pittsburgh, Pa.
Boiler drop plugs	Nathan Manufacturing Co., New York
Firebox steel; tank steel in boiler; smokebox plates; engine bolt iron	Bethlehem Steel Co., Bethlehem, Pa.
Boiler flange steel	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Boiler braces; drawbar and safety bar; drawbar pins	Lockhart Iron & Steel Co., McKees Rocks, Pa.
Boiler lagging	Johns-Manville Sales Corp., New York
Boiler jacket	Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Cab steel plate	The Weirton Steel Co., Weirton, W. Va.
Cab insulation:	
Fiberglas (6)	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Hairinsul (6)	Johns-Manville Sales Corp., New York
Cab-seat cushions	Dunlop Tire & Rubber Corp., Buffalo, N. Y.
Cab window glass	American Window Glass Co., Pittsburgh, Pa.
Window sash	Aluminum Co. of America, Pittsburgh, Pa.
Cab ventilators (side)	The Prime Manufacturing Co., Milwaukee, Wis.
Tread plate, Inland four-way	Joseph T. Ryerson & Son, Inc., Chicago
Stoker	Standard Stoker Co, Inc, New York
Grates (Firebar)	Waugh Equipment Co, New York
Ashpan plates	Otis Steel Co., Cleveland, Ohio
Soot blowers	Superior Railway Products Corp., Pittsburgh, Pa.
Firedoor; sleeve joints	Franklin Railway Supply Co., Inc., New York
Equalizer pins and bushings	Ex-Cell-O Corporation, Detroit, Mich.
Injector	Nathan Manufacturing Co., New York
Exhaust-steam turbo feed-water heater	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Steam-heat reducing valve and stop valve	Vapor Car Heating Co., Inc., Chicago
Steam gage; steam-heat gage; stoker gage; safety valve	Ashton Valve Co., Boston, Mass.
Steam-pipe covering; smoke-box tape	Union Asbestos & Rubber Co., Chicago
Pipe, wrought iron	A. M. Byers Co., Pittsburgh, Pa.
Pipe unions	The Corley Co., Jersey City, N. J.
Blow-off separator and discharge muffler	Wilson Engineering Corp., Chicago
Saturated steam valves	Crane Co., Chicago
Superheated steam valves	Walworth Co., New York
Water gage	Nathan Manufacturing Co., New York
Back-pressure gage; water-level indicator	Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Train indicators	The Adams & Westlake Co., Elkhart, Ind.
Signal Foam-Meter	Electro Chemical Engineering Corp., Subsidiary of Dearborn Chemical Company, Chicago
Valve Pilot	Valve Pilot Corporation, New York
Sander	Viloco Railway Equipment Co., Chicago
Automatic drain cocks	The Okadee Company, Chicago
Bell ringer	Transportation Devices Corp., Indianapolis, Ind.
Horn	The Leslie Co., Lyndhurst, N. J.
Headlight and headlight wiring fixtures	Pyle-National Co., Chicago
Headlight generator	Sunbeam Electric Mfg. Co., Evansville, Ind.
Wiring, electric	General Cable Corporation, New York
Tender:	
Frame	General Steel Castings Corp., Eddystone, Pa.
Truck	Buckeye Steel Castings Co., Columbus, Ohio
Volute spring snubbers	The Holland Co., Chicago
Wheels	Standard Steel Works Co., Burnham, Pa.
Journal-box lids	The Symington-Gould Corp., Rochester, N. Y.
Bearings	Magnus Metal Div., National Lead Co., New York
Brake shoes	American Brake Shoe & Foundry Co., New York
Clasp brakes	American Steel Foundries, Chicago
Hand brakes; draft gear	W. H. Miner, Inc., Chicago
Coupler and coupler yoke	National Malleable and Steel Castings Co., Cleveland, Ohio
Tank steel	Jones & Laughlin Steel Corp., Pittsburgh, Pa.
Tank hose	Quaker City Rubber Co., Philadelphia, Pa.
Dust guard	MacLean-Fogg Lock Nut Co., Chicago
Coal pusher	Standard Stoker Co., New York
Lacquer (6)	Pittsburgh Plate Glass Co., Pittsburgh, Pa.
(6)	E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Jacks	The Duff-Norton Manufacturing Company, Pittsburgh, Pa.
Wrenches	J. H. Williams & Co., New York

Low Water Alarm with Two Warning Whistles

The familiar type of float low-water alarm, supplied by the Barco Manufacturing Company, Chicago, has recently been equipped with an additional whistle connection in the cab which gives a double alarm feature, designed to furnish adequate warning in cases of low water under all operating conditions. The large whistle at the alarm on the outside of the boiler gives warning to terminal forces when the locomotive may be on some outlying track, and the smaller whistle in the cab gives a direct indication to the engine crew when the locomotive may be working hard and the cab is closed with storm curtains, or has a vestibule construction which more or less excludes outside sounds and noises.

The provision of the second whistle, installed in the cab, is designed to assure that, under no possible operating condition, can there be an excuse for engine crews not hearing the warning signal in the cab.



Barco float low water alarm, equipped with a supplementary small whistle and drain pipe in the cab

High Tensile Steel Used in Construction of

D. & H. Lightweight Coaches

WITHIN the past two months the Delaware & Hudson installed six 76-passenger coaches, of lightweight welded construction in service on important main-line trains, such as the "Laurentian," between New York and Montreal, Que. These coaches embody the use of U SS Cor-Ten and carbon steel structural shapes in the side and underframing, Armco HT50 sheets in the car sides and roof and Republic RDS pressed framing members.

The cars are designed with large vestibules at each end, equipped with folding steps. The door openings in the vestibules are 36 in. wide. The interior of the cars is arranged with a 65 ft. 1 in. passenger-carrying space with women's and men's rooms at one end of the car,

The vestibules have folding steps

together with a luggage compartment with shelves on one side of the car adjacent to the men's room. The space occupied by the latter facilities is 8 ft. 10⅞ in. The aisle width is 2 ft. 2¼ in.

Car Structure

The underframe is built up of a rolled Z-section side sill and a standard A. A. R. center sill section of open hearth steel having a 36,000 lb. per sq. in. yield point. An open hearth steel bottom cover plate is used to lower the neutral axis of the section to a point near the center line of draft. These two rolled sections are framed together with light-pressed channel floor beams which run continuously from side sill to side sill over the top

One of the lightweight coaches built for the D. & H. by American Car & Foundry Company

Interior framing and insulation

of the center sill. The cross bearers are made by dropping a web plate from the above-mentioned floor beam and adding a rolled angle bottom chord.

The bolster is of welded construction consisting of low alloy steel top and bottom cover plates which are welded

Table I—Principal Weights and Dimensions of Delaware & Hudson Coaches

Length over buffers, uncoupled, ft.-in.	84-9
Length over coupler pulling faces, ft.-in.	84-3
Truck wheel-base, ft.-in.	9-0
Truck centers, ft.-in.	58-6
Width over side posts, ft.-in.	10-0
Width inside, ft.-in.	9-5⅜
Height, rail to floor, ft.-in.	4-3¾
Height, rail to top of roof, ft.-in.	13-6
Weight, light, total, lb.	112,920
Weight of one truck, without generator drive, lb.	18,140
Weight of truck with Spicer drive, lb.	18,800

to web plates of the same material. This box section is further stiffened over the side bearing by the addition of web and flange stiffeners.

Light gage steel false floor sheets were then tack-welded to the underframe members, thus forming a water-tight, fire-proof bottom covering for the floor. Z-shaped lightweight stringers are then laid longitudinally and securely fastened to both the false floor sheets and the underframe cross members. Chanarch flooring ⅝-in. in depth is fastened to these stringers with machine screws. The underframe is an arc-welded structure.

The side framing is of girder type construction with a rolled-angle side sill or bottom chord and a lightweight Z-bar rolled side plate or top chord member. The posts are a pressed flanged U-section which, when spot welded to 14-gage side sheets, make a stiff but light box section. The belt rail and window headers consist of pressed Z-shaped members, and are so fastened to the side posts that they function as continuous members.

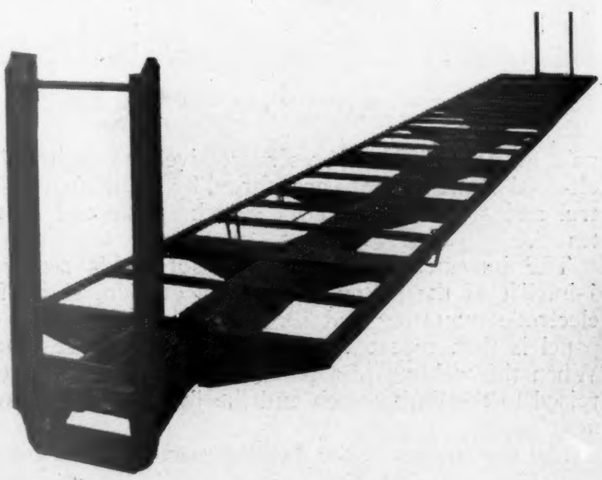
The roof framing consists of a lightweight side plate angle to which is arc welded pressed Z-shaped carlines. Four Z-shaped purlines are welded to the carlines and run the entire length of the car and when spot welded together with the carlines and the .06-in. roof sheets form a substantial and stiff unit when finally fastened to the two sides of the car shell. Further rigidity is gained by the light trussed framing which is welded to the carline to house the air-conditioning duct and support the head-lining.

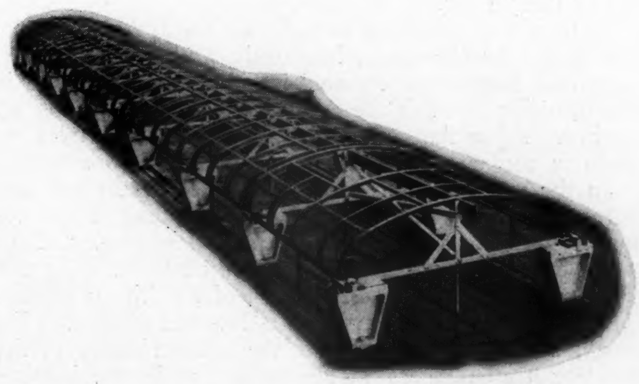
Method of Spot Welding

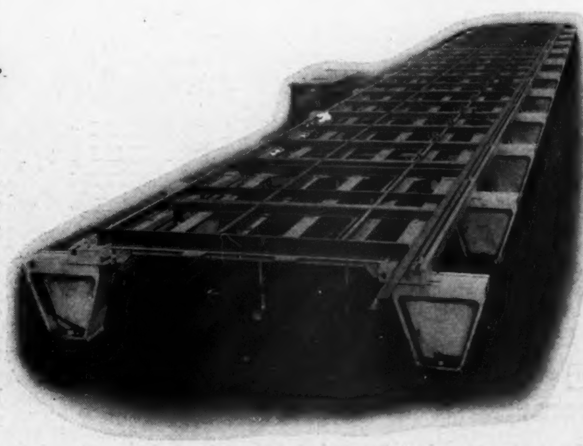
In fabricating the major units of these cars such as the sides, ends, and roof, the spot welding is performed by a multiple spot-welding machine. Preliminary to the spot-welding operations the side framing and roof framing is assembled in an accurate jig. In one case the post and side members are arc-welded together and, in the case of the roof, the carline and purlines are arc-welded together. The outside sheets of the side and the roof are then attached. The units, in their fitted position, are then ready to go to the spot welder.

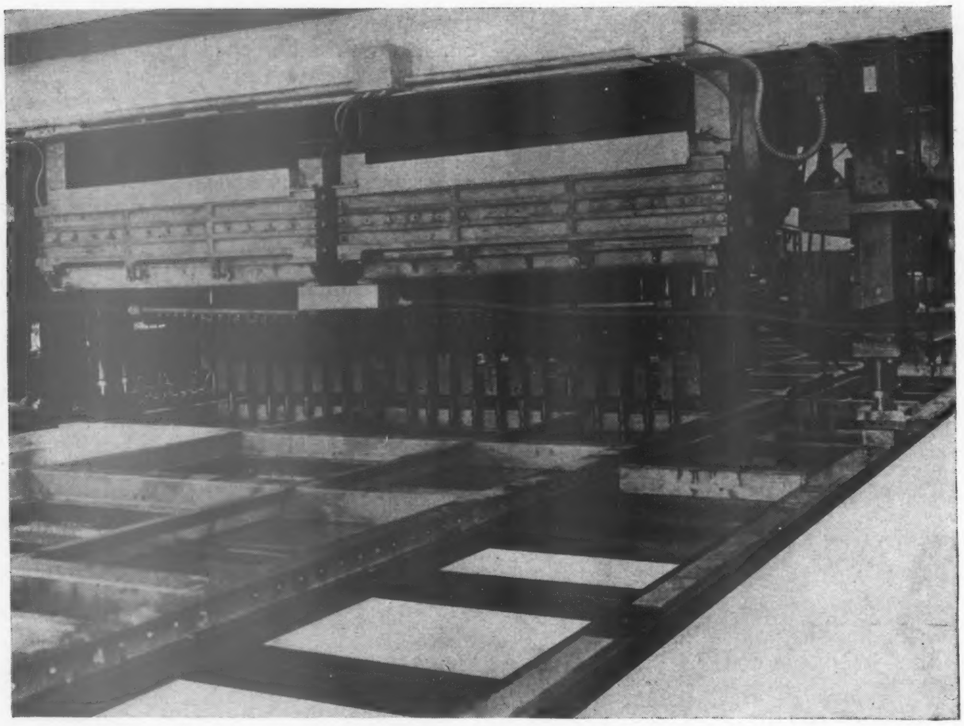
The semi-automatic welding machine consists of a platen, upon which is mounted the multiple electrode

Below, at left: The completed arc-welded underframe and end structure—USS Cor-Ten and carbon steel shapes were used—The other two views show a side frame and roof frame in jigs ready for the spot welder







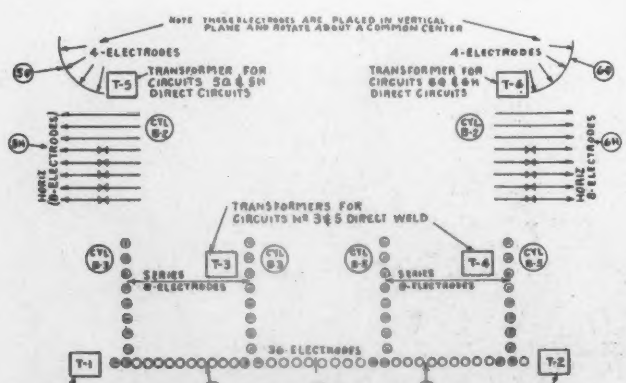


The platen and electrodes—The transformer contact shoe is seen at the right

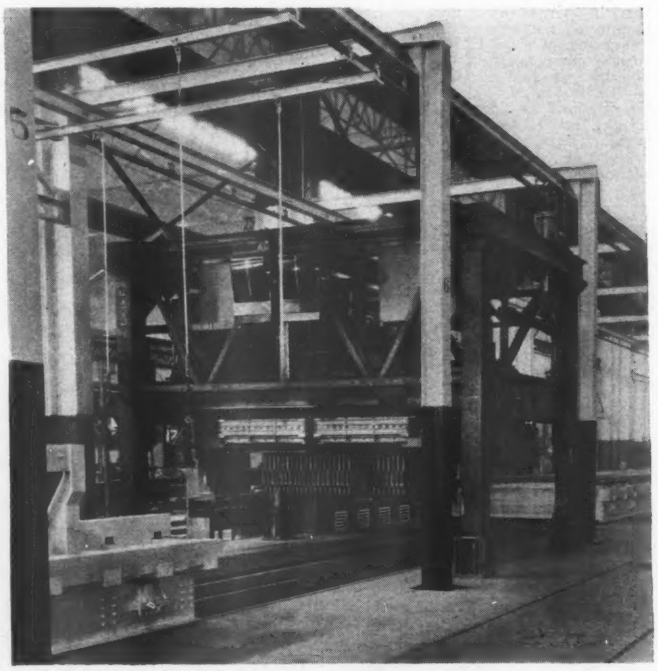
set-up, and a transfer welding-jig car, which moves on the track under the platen. The platen of the machine is lowered vertically with its electrodes to make contact with the work. In the set-up of the electrodes, they are spaced to meet the location requirements of the design of the car. Successive panels are welded by the indexing of the jig car.

In lowering the platen to make the weld, the electrodes are under pressure simultaneously and act as a self-contained clamp at each weld location. They remain in that position through the entire cycle of the welding sequence. After the current is cut off the electrodes remain in contact as a clamp until the welds are cooled.

In the welding of a car side, the operations are performed panel by panel. The side framing units, together with the side sheets, are placed, in proper alignment, on a copper grillage which is a part of the jig car. The grillage is the secondary part of the jig-car circuit. The platen, with its electrodes, is lowered to contact the work, and, at the same time, the contact shoes of the welding transformers make contact with the bus-bar grillage. Motor-driven secondary distributing switches



Electrode set-up for flat and curved parts of roof

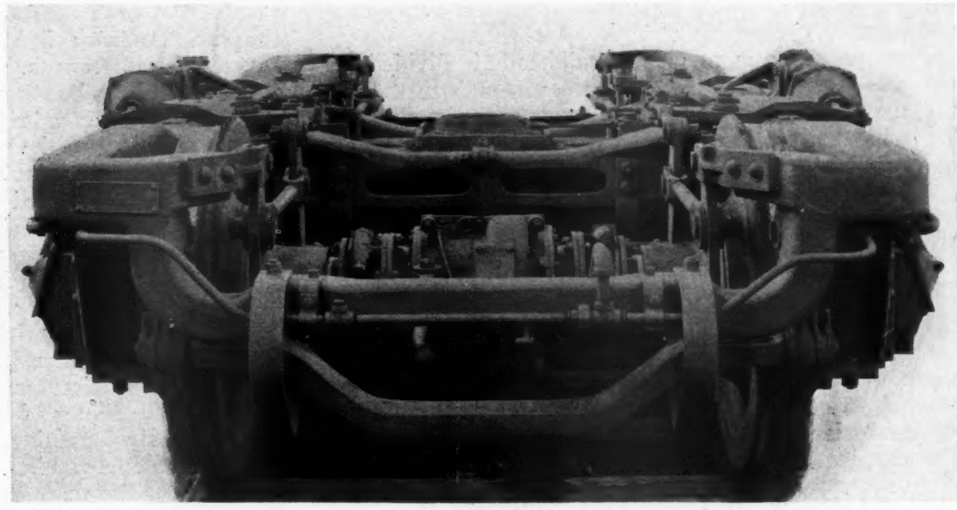


Automatic spot welder and welding jig cars

pass about 20,000 amperes successively to each welding electrode. The switches are started by a push-button control and stopped by a limit switch at the end of their travel.

The intermediate spacing of spot welds requires a 1-in. lift of the platen and a 1-in. or 2-in. shift of the electrode mounting and shifting slide. The cycle of a panel is then repeated as required to meet the spacing. When the welding of a panel is complete, the platen is raised to the limit switch and the jig car indexed to the next panel.

The movements of the welding machine units are con-



One of the trucks with the Spicer generator drive — These trucks have balanced, ground wheels, clasp brakes and weigh 18,800 lb.

trolled from a central operator's station. Any one of a dozen operations are controlled manually and individually. A dozen operations may be executed automatically as one by means of a selector switch.

The electrode set-up for welding one panel of a car side is similar to that used in welding a panel of the flat portion of a car roof. In welding a roof panel, the operations are performed in two positions. The first position (on the flat portion) utilizes 4 transformers, 4 secondary switches, and 68 electrodes arranged in four groups as shown in the lower portion of the accompanying diagram. The second position, during which the welding operations on the curved portion of the roof are performed, utilizes 2 transformers, 2 secondary switches, and 24 electrodes arranged in four groups. Two groups of four electrodes each on a quadrant complete the carline weld on the curvature. Two groups of eight electrodes each mounted horizontally take the eave angle to the roof sheets. Upon the completion of these two position operations, which complete a panel, the platen is raised to the limit switch and the jig car indexed for the next panel.

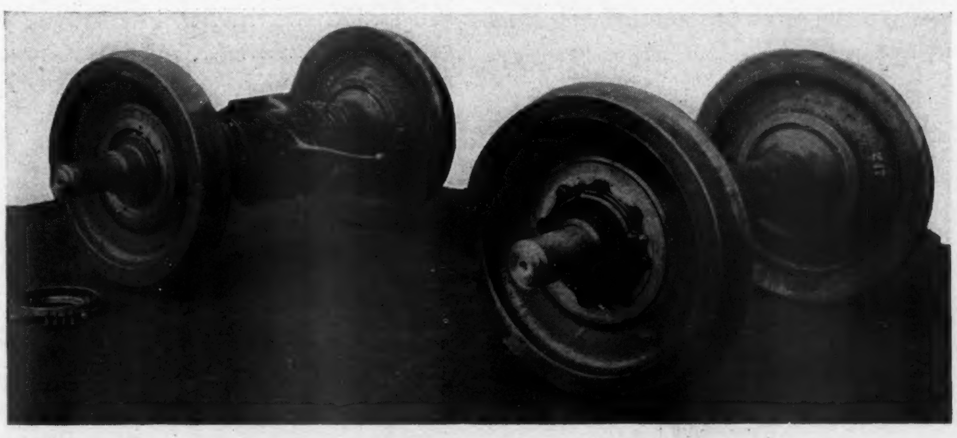
Exterior and Interior Decoration

These new coaches were styled by Raymond Loewy. The exterior is painted a dark green with a soft gray panel, accented with an orange stripe used to outline the outside window areas. Lettering, numbering and the railroad company monogram are all done in golden yellow.

For the interiors of the six coaches, three alternate color schemes have been chosen; the architectural and design features are similar. For instance, in all the coaches the end seats in each car have been given an

Table II—Color Schemes for Interiors

Location	No. 1	No. 2	No. 3
Ceiling	Pale yellow	Pale yellow	Sun tan
Bulkhead panels	Silver opalescence and moss green	Silver opalescence and delft blue	Rose opalescence and apple green
Walls, pier panels, dado and Pantasote curtains	Various tones and shades of moss green	Various tones and shades of delft blue	Various tones and shades of apple green
Seats	Soft gray and cedar rose	Soft gray and cedar rose	Mahogany rose and Moorish green
Colors accents	Red and yellow	Dusty rose	Yellow and autumn red
Flooring	Sand jaspe with black inlay	Sand jaspe with mahogany inlay	Sand jaspe with mahogany inlay
Headrests	Beige	Beige	Beige



A pair of truck wheels showing the roller bearing units

entirely different color treatment from the majority of the seats.

The paint treatment on the bulkheads is divided into two panels; the inner panel carries through to the ceiling, the outer one becomes continuous with the side wall. To achieve this, sharp contrast in light values is employed. These color schemes are shown in Table II.

Another feature of these coaches is the manner in which linoleum has been used as floor covering in simple, geometric inlay.

Sand colored Jaspe is contrasted with solid black in one of the schemes, while an alternate makes use of antique mahogany as a distinguishing note.

Other special materials include the use of satin-finish aluminum for basket racks, trim, etc.; the selection of Marlite—a colorful modern tile—for the wainscoting in the lavatories; and the use of black Micarta for all window capping.

Lighting and Electrical Equipment

Simplicity and compactness has been achieved in the design of the air-conditioning ducts and center lighting trough. A special type of illumination has been used involving a center ceiling fixture running the length of the car. Indirect light emanates from the aluminum lacquered light trough. This center trough contains 64 thirty-watt Lumiline lamps. The air ducts or louvers are trimmed with a bright red. The principal interior illumination is furnished by 38 forty-watt Safety circular ceiling lights with double prismatic lenses, the lenses having an edge-lighted skirt. There is one of these lights over each double seat. There are also two of these fixtures in the passageways and one in the men's saloon. Column lights are used in the women's room. The vestibule lights are Safety units equipped with semaphore lenses. The total lighting load in the car is 3,640 watts. The illumination intensity on the 33-in., 45-deg. reading plane with the circular ceiling lights only is 8.5 foot-candles at the center of both seats and in the aisle. The addition of the Lumiline lamps raises the intensity in the aisle to 12.5 foot-candles.

Power for the three cars is supplied by 20 kw. Safety Genemotors and on the other three by 20 kw. General Electric generators. All generators are driven by Spicer drive with automatic clutch on the Safety equipment and

(Continued on page 20)

Partial List of Materials and Equipment on the Delaware & Hudson Lightweight Coaches

Aluminum	Aluminum Co. of America, Pittsburgh, Pa.
Steel:	
Side and roof sheets	Armco Railroad Sales Co., Middletown, Ohio
Pressed frame members	Republic Steel Corp., Massillon, Ohio
Structural shapes in side and underframe	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Trucks	General Steel Castings Corp., Eddystone, Pa.
Wheels	Bethlehem Steel Co., Bethlehem, Pa.
Axles	Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Roller bearing units	American Steel Foundries, Chicago
Roller bearings	SKF Industries, Philadelphia, Pa.
Journal bearings	Magnus Metal Corp., New York
Side bearings	Alcoma Railway Equipments, Chicago
Locknuts	Columbia Nut & Bolt Co., Bridgeport, Conn.
Journal boxes	National Malleable and Steel Castings Co., Cleveland, Ohio
Dust guards	W. N. Thornburgh Mfg. Co., Chicago
Bolster locking pin; safety locking center pin	W. H. Miner, Inc., Chicago
Springs	Union Spring & Mfg. Co., New Kensington, Pa.
Buffer springs; Fowler upper	Standard Railway Equipment Co., Chicago
Friction buffers; draft gear	W. H. Miner, Inc., Chicago
Tight Lock couplers	National Malleable and Steel Castings Co., Cleveland, Ohio
Air brakes	New York Air Brake Co., New York
Hand brake	W. H. Miner, Inc., Chicago
Clasp brake	American Steel Foundries, Chicago
Brake shoe	American Brake Shoe & Foundry Co., New York
Safety step treads	The Morton Mfg. Co., Chicago
Trap door and folding steps	The O. M. Edwards Co., Inc., Syracuse, N. Y.
Vestibule diaphragms and fixtures	Excel Curtain Co., Elkhart, Ind.
Vestibule diaphragm curtains	The Pantasote Co., Inc., New York
Window sash, dehydrated	The O. M. Edwards Co., Inc., Syracuse, N. Y.
Window sash glass	Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Window glass, toilets and wash rooms	Pressed Prism Plate Glass Co., Chicago
Window sill, Micarta	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Window shades	The Pantasote Co., Inc., New York
Inside facing	L. C. Chase & Co., Inc., New York
Glazing cork strip	Armstrong Cork Products Co., Lancaster, Pa.
Doors, aluminum and steel	American Car and Foundry Co., New York
Flooring	Tuco Products Co., New York
Flooring, vestibules	Alan Wood Steel Co., Conshohocken, Pa.
Linoleum and rubber floor covering	Armstrong Cork Products Co., Lancaster, Pa.
Linoleum inlays	Sloane-Blabon Corp., New York
Chanarch floor	The Morton Mfg. Co., Chicago
Conduit fittings	Thomas & Betts Co., Elizabeth, N. J.
Copper tube and fittings	American Brass Co., Waterbury, Conn. Chase Brass & Copper Co., Inc., Waterbury, Conn. Mueller Brass Co., Port Huron, Mich.
Insulation:	
Stonefelt and Wovenstone	Johns-Manville Sales Corp., New York
Fiberglas	Gustin-Bacon Mfg. Co., Kansas City, Mo.
Weatherstrip	Durkee-Atwood Co., Minneapolis, Minn.
Air conditioning	General Electric Co., Schenectady, N. Y. Safety Car Heating & Lighting Co., New York
Air-conditioning controls	Vapor Car Heating Co., Inc., Chicago
Air-conditioning grilles	Hart & Cooley Mfg. Co., Chicago
Air-conditioning grille cores	Barber-Colman Company, Rockford, Ill.
Air-conditioning filters	Owens-Illinois Glass Co., Toledo, Ohio
Registers	Tuttle & Bailey, Inc., New Britain, Conn.
Fin-tube heating unit	Vapor Car Heating, Inc., Chicago
Generator drive with safety and automatic clutches	Spicer Mfg. Corp., Toledo, Ohio
Pipe clamp	Illinois Railway Equipment Co., Chicago
Ventilators	Railway Utility Co., Chicago
Auxiliary fans	Diehl Mfg. Co., Elizabethport, N. J.
Electrical equipment	Safety Car Heating & Lighting Co., New York General Electric Co., Schenectady, N. Y.
Light fixtures	Safety Car Heating & Lighting Co., New York Bryant Electric Co., Bridgeport, Conn.
Batteries	Edison Storage Battery Div., Thomas A. Edison, Inc., W. Orange, N. J.
Charging receptacle; train-line connectors	The Pyle-National Company, Chicago
Seats	Heywood-Wakefield Co., Gardner, Mass.
Seat cushions	Dunlop Tire & Rubber Corp., Buffalo, N. Y. B. F Goodrich Co, Akron, Ohio U. S. Rubber Co., N. Y.
Seat covering	Chase, L. C. & Co., Inc., New York Massachusetts Mohair Co., Chicago
Tempered Presdwood	Masonite Corp., Chicago
Marlite	Marsh Wall Products, Inc., Dover, Ohio
Fabreeka	Fabreeka Products Co., Inc., Boston, Mass.
Hoppers	Dayton Mfg. Co., Dayton, Ohio
Washstands	Crane Co., Chicago
Paper towel containers; toilet paper holder	Albany Perforated Wrapping Paper Co., Albany, N. Y.
Water cooler	Henry Giessel Company, Chicago
Drinking-cup containers	U. S. Envelope Co., Springfield, Mass.
Disinfectant	U. S. Sanitary Specialties Co., Chicago
Tail gates; luggage racks	The Adams & Westlake Co., Elkhart, Ind.
Snap-on molding	Pyramid Metals Co., Chicago
Door closer	Russell & Erwin Mfg. Co., New Britain, Conn.
Locks	Yale & Towne Mfg. Co., Phila., Pa. Dayton Mfg. Co., Dayton, Ohio James L. Howard, Bridgeport, Conn.
Anti-pinch shield (end doors)	The Morton Mfg. Co., Chicago
Fire extinguisher	Pyrene Mfg. Co., Newark, N. J.
Steam-heat connectors	Barco Mfg. Co., Chicago
Paint:	
Exterior	E. I. duPont de Nemours & Co., Inc., Wilmington, Del.
Interior	Sherwin-Williams Co., Cleveland, Ohio Murphy Varnish Co., Newark, N. J.

Bureau of Safety Reports on

"City of San Francisco" Wreck

Derailed cars destroyed a 120-ft. Warren truss bridge and the wreckage of the train was entangled with the demolished bridge structure

THE disastrous wreck of the streamliner "City of San Francisco" on the evening of August 12, 1939, while traveling westward in Northern Nevada, was caused by "malicious tampering with the track," according to the report of the Bureau of Safety of the Interstate Commerce Commission, released December 29 following a thorough investigation on its part. According to all testimony taken at the Bureau's inquiry, including that of its own inspectors, indications are that a joint on the high rail of the curve involved had been disconnected, the angle bars removed, and the east end of the receiving rail moved inward about 4⅝ in. on the tie, setting up an ideal derailing condition—an act of deliberate sabotage.

The accident, which resulted in the death of 9 passengers and 15 dining-car employees, and the injury of 99 passengers, 1 train-service employee, one stewardess, 11 dining-car employees, and 3 train porters, occurred on the line of the Southern Pacific at a point approximately 1.55 miles east of the station at Harney, Nev., and 169.5 ft. east of bridge No. 518.54 over the Humboldt river. Approaching from the east, there is a tangent 437 ft. in length, followed by a 3-deg. curve to the right, extending 875 ft. to the point of derailment and 1,215 ft. beyond. Bridge No. 518.54 was a through riveted Warren truss span, 120 ft. long, which had recently been strengthened and was capable of carrying Cooper's E-50 loading.

Following is the text of that part of the report pertaining to the damage to the rolling stock:

Consist of the Train

No. 101, a westbound streamline passenger train, known as the "City of San Francisco," consisted of 3 power units, an auxiliary power and dormitory unit, 2 chair units, 2 kitchen-diner units, 1 dormitory-club unit, 7 Pullman sleeping units and 1 lounge unit, in the order named, and was in charge of Conductor Edwards and Engineman Hecox. The three power units were of steel-frame construction; the bodies were of ⅜-in. plywood covered with 27-gage galvanized iron. The remainder of the units were of aluminum alloy with steel end-sills, body bolsters and cross bearers.

This train departed from Carlin (Nev.) 16 miles east of the point of accident, at 9:15 p. m., according to the train sheet, 29 min. late, and 18 min. later became derailed 169.5 ft. east of Bridge 518.54, while moving at a speed of 60 m. p. h. The three power units and the following two units, remaining coupled, became derailed, passed over the bridge on the ties, and stopped with the front end about 907 ft. west of the point of derailment. Power unit No. 1, slightly damaged, stopped upright on the ties at approximately 11 in. to the left of the line of track. Power unit No. 2, slightly damaged, and inclined at an angle of 15 deg. to the left, stopped with its front truck on the ties about 12 in. to the left of the line of track and its rear truck on the ballast. Power unit No. 3, inclined to the left at an angle of 45 deg., stopped with its front end on the fill and its rear end down the embankment, the left eave of this unit bearing indications of having struck the bridge truss; the front truck was damaged considerably. Unit No. 4 stopped on its left side down the embankment to the south of the track; its side sheets were raked and broken through by the ballast; it bore marks indicating that it had struck the south bridge-truss. Unit No. 5 stopped on its left side down the embankment to the south of the track, with the rear end 200 ft. west of the west bridge-abutment; its side sheets were sheared in numerous places and it was crushed inward along the window belt-rail; its left front corner bore marks indicating that it had struck the left bridge-truss; the tight-lock coupler at the rear was broken through the shank. Unit No. 6, a diner-kitchen car, the front section of an articulated two-unit car, became derailed and struck the bridge-truss, causing the bridge to collapse; it broke loose from the preceding unit, struck the west bridge-abutment with such force that the impact moved the abutment 1½ in. out of line, passed over the abutment, overturned to the left down the embankment west of the bridge, stopped upside down, and was practically demolished; the steel end-sill was broken loose from the aluminum alloy center-sills, which were broken about the middle of the car and were badly bent in other places; all the occupants of this unit were killed. Unit No. 7, a dining car, became derailed and was deflected to the left by the impact with the preceding car; it turned at an angle of 45 deg. and stopped about 90 ft. south of the track in the river bed; the body of the car was demolished and the frame badly distorted; the center-sills were broken just back of the bolster. Of the 24 persons killed, 21 were occupants of units Nos. 6 and 7. Unit No. 8, a dormitory-club car, became derailed, was whirled by the deflecting motion of the preceding unit, and, using the bridge frame as a fulcrum, struck the left bridge-truss with an impact sufficient to demolish the truss; the center-sills were broken at the rear bolster, at the needle beams, and at the rear-end sill; the body above the floor line was badly crushed and twisted; unit No. 9, dragging heavily as the whirling motion was being executed, caused the center-sills of unit No. 8 to be broken through at the rear end; unit No. 8 fell to the river bed and stopped upright but off its trucks; it was crushed badly at both ends. Unit No. 9, a Pullman sleeping car, articulated with unit No. 10, became derailed and dropped through the bridge opening to the river bed, stopping upright, south of and at an angle of 30 deg. to the track; its rear end was crushed inward as far as the cross-bearer or about 15 ft. from the articulated joint; the rear coupler-head was broken off, and the center-sills were broken through; the roof was crushed inward by unit No. 10 falling across it; unit No. 9 was demolished; two passengers and one porter in this car were killed. Unit No. 10, a Pullman sleeping car, became derailed, fell through the bridge opening, and stopped on the roofs of units Nos. 8 and 9, and on the overturned floor structure of the bridge;

one end was pointed upward; this car was crushed and badly distorted. These three cars, units Nos. 8, 9 and 10, were entangled with the demolished bridge structure. Unit No. 11, a Pullman sleeping car, articulated with unit No. 12, became derailed to the south at an angle of 25 deg. to the track and stopped upright in the river bed with its front end badly damaged and its rear end suspended upon the east bridge-abutment. Unit No. 12, a Pullman sleeping car, became derailed, but remained coupled to unit No. 11 and stopped upright on the embankment east of the bridge opening; one end was damaged slightly. Unit No. 13, a Pullman sleeping car, articulated with unit No. 14, became derailed but remained coupled to the units at each end and stopped upright, slightly damaged, with its front truck on the embankment and its rear truck on the ties. Unit No. 14, a Pullman sleeping car, became derailed at the front end only and remained coupled at each end. Units Nos. 15, 16, and 17 were not derailed and sustained but slight damage.

The streamline train, "City of San Francisco," was owned jointly as follows: C. & N. W., 21.63 per cent; S. P., 34.19 per cent; and U. P., 43.88 per cent.

The center of gravity of the Diesel-powered units on this train was 57 in. above the top of the rail. The overturning speed on a 3-deg. curve, with superelevation of 4 in., is 124.5 m. p. h., and a speed of 60 m. p. h. is well within the limits of safe practice as recommended by the American Railway Engineering Association.

The three power units were constructed by the Electro-Motive Corporation according to the carriers' specifications; the frames were of molybdenum steel, in rolled sections, the sides of 27-gage galvanized iron over ⅜-in. plywood, and the trucks were six-wheel type with motors mounted on the leading and trailing axles of each truck. The cars were constructed by the Pullman-Standard Car Manufacturing Co., according to the carriers' specifications; the end sills, bolsters, and needle beams were of Cor-Ten steel, of welded construction, the yield point being a minimum of 50,000 lb. per sq. in. and the ultimate strength a minimum of 70,000 lb. per sq. in. The center sills, side sills, posts, carlines, sheathing, roof, and all other framing were of aluminum alloy, the properties of which were as follows:

Material	Dimension, in.	Minimum tensile strength per sq. in., lb.	Minimum yield strength (at 2 per cent off-set) per sq. in., lb.	Minimum elongation in 2 in., per cent
Sheet and plate (17S-T) ..	0.041-0.128	55,000	32,000	18
	0.129-0.258	55,000	32,000	15
	0.259-0.500	55,000	32,000	12
Rolled shapes (17S-T)	....	50,000	30,000	16
Extruded shapes	....	50,000	35,000	12
Extruded shapes (A17S-T)	....	35,000	20,000	18
Sheet (4S½H)	0.051-0.113	30,000	24,000*	5
	0.114-0.203	30,000	24,000*	6

* Approximate.

Typical shear strengths were as follows:

	Lb. per sq. in.
17S-T	36,000
A17S-T	26,000
53S-T	24,000
4S-½H	18,000

The specifications provided for a buffing stress of 400,000 lb. at draft gear without the use of buffers. All couplers were improved tight-lock, EMC design, rubber-cushioned draft gears. The construction of this train was completed December 27, 1937, and it was placed in service January 2, 1938. The builder's records indicate that this equipment was built according to Post Office Department specifications of 400,000 lb. buffing stress, with a safety factor of two, which fixes the minimum for actual failure at 800,000 lb.

The records of the Pullman Car Company indicate that a test was conducted February 16, 1937, using a 7-ft. 10-in. section of the underframe taken from the center of a car, and containing the center-sill, side-sills, floor-stringers, one steel cross bearer, and three aluminum floor supports. This section withstood a compression load of 880,000 lb. before any permanent deformation resulted. On September 17, 1939, a test was made on a section of the center-sill cut out of the frame of the car "Twin Peaks," which was the ninth unit in the derailed train. The results of this test were as follows:

Item	No. 1	No. 2	Specification minimum
Yield point, lb. per sq. in.	35,000	34,000	39,000
Tensile strength, lb. per sq. in.	55,830	55,500	50,000
Elongation 8 in., per cent	20.7	20.3	.....
Reduction of area, per cent	28.9	26.9	.....

On October 3, 1939, the Aluminum Company of America, at its research laboratories, New Kensington, Pa., tested for tensile properties a portion of the web, the bottom flange of one channel, and the bottom angle of the center-sill of the ninth unit, the results of these tests being as follows:

Location	Tensile strength, lb.	Yield strength, set—0.2 per cent per sq. in., lb.	Elongation in 2 in., per cent	Reduction of area, per cent
Angle	56,320	37,500	25.0	38.9
Channel web	56,030	34,700	24.0	34.3
Channel toe	56,770	37,100	24.5	35.7
Channel heel	56,750	39,100	24.0	40.8
Average	56,470	37,100	24.4	37.4
Specified minimum	50,000	30,000	16.0	...

The following is a statement of damage as formulated by the carriers and the Pullman Company:

Position in train, Unit No.	Name	Damage
1	Power unit (S.F. 1)	$11,000.00
2	Power unit (S.F. 2)	11,500.00
3	Power unit (S.F. 3)	14,000.00
4	Baggage-dormitory (S.F. 101)	43,500.00
5	Market Street (S.F. 401)	45,000.00
6	Presidio (S.F. 601)	117,073.29*
7	Mission Dolores (S.F. 602)	103,199.37*
8	Embarcadero (S.F. 701)	118,337.90*
9	Twin Peaks (N-120)	90,658.36*
10	Chinatown (N-121)	86,446.28*
11	Fisherman's Wharf (N-122)	18,500.00
12	Golden Gate Park (N-123)	8,500.00
17	Nob Hill (S.F.)	2,600.00
	Total	670,315.20

* Demolished.

Observations of the Commission's Inspectors

The trucks of the power units were examined, and it was observed that the motor housings and the pedestal binder bolts showed considerable wear, indicating abrasive action obviously sustained by sliding on the top of the rails. Grooves on the left side of the motor housings of power units Nos. 1, 2, and 3 indicated contact with the top of the rails; on all motor housings the grooves were worn to a depth which varied between $\frac{3}{32}$ in. and $\frac{7}{16}$ in. These marks were blue in color, which indicated friction burning. Holes in the motor housings indicated probable contact with the bridge guardrail. The inner faces of the right-pedestal binder-bolt nuts, which were 1-in. hexagonal nuts, were severely abraded and burned because of contact with the outside of the ball of the north rail, except one nut at the right No. 2 wheel of truck No. 1 of power unit No. 1, which was worn to less than half its thickness; it was fused to its bolt, evidently due to sliding on top of the rail head. There was somewhat greater wear on the motor housings and the pedestal binder-bolts on unit No. 1 than on the two following units.

The inspectors observed that the cars withstood impact shock up to a certain degree, after which some of

(*Continued on page 19*)

Designing for

High Tensile Steels*

By H. M. Priest†

Charts and formulas for the solution of problems involving a combination of stresses and working formulas based on the specification for post office cars are presented

Combined Stresses

MANY structural members are subjected to a combination of loads that produce a combination of stresses. One of the most frequent combinations is that of direct compression and bending. Several charts, to be presented, will be found useful in the solution of such problems. Fig. 18 is illustrative of a few ways in which compression and bending are combined.

Fig. 18 (a) represents a column or compression member in which the applied load, P, has an eccentricity, e, with respect to the neutral axis of the section. The moment, Pe, produces a deflection of the column in the direction of the dotted line. The additional deflection adds to the arm of the load P at the center, thereby increasing the moment and adding another increment to the deflection. The dotted line indicates the elastic line of the column when it finally reaches equilibrium with a deflection Δ. The moment then equals $P \times (e + \Delta)$.

From integral calculus an expression for this moment can be obtained and is represented by the following equation.

$$\text{Maximum moment} = M \sec \frac{\pi}{2}\sqrt{\frac{P}{P_{cr}}} \quad \ldots\ldots (56)$$

in which

M = Moment Pe, in-lb.
P = Load on column, lb.
$P_{cr} = \dfrac{\pi^2 EI}{L^2}$, lb.
I = Moment of inertia of column, in.^{4}
L = Unsupported length of column in.
E = Modulus of elasticity, lb. per sq. in.

The combined stresses in the column will be given by the following formula, in which the first term is the average compression and the second term represents the fibre stress in bending. The negative sign represents compression and the positive sign is for tension.

$$\text{Total stress} = -\frac{P}{A} \pm \frac{\text{Max. Mom.}}{S} \quad \ldots\ldots\ldots (57)$$

in which

A = Area of column section
S = Section modulus of column section

The examination of an eccentrically-loaded column will be facilitated by the chart of Fig. 19 which is based on the formula

$$S_{max}\left(\frac{L}{r}\right)^2 = \frac{PL^2}{Ar^2}\left[1 + \frac{e}{s}\sec\sqrt{\frac{1}{4E}\frac{PL^2}{Ar^2}}\right] \quad (58)$$

in which

S_{max} = Total maximum stress in compression, lb. per sq. in.
e = Eccentricity of load P, in.
s = Ratio of $\dfrac{\text{section modulus}}{\text{area}}$

The ratio e/s in Formula 58 is the same as $a = ec/r^2$ in the column secant formula discussed in Part I.

The application of the chart to a specific example will best illustrate its use. Take the column shown in Fig. 18 (d) with an unsupported length of 462 in. Let the problem be the determination of the maximum load P, acting with an eccentricity of 3.60 in. In the discussion of compression members in Part I, it was stated that the ultimate stress in a column is the yield-point stress of the steel. For this example, assume the yield point equals 33,000 lb. per sq. in. and S_{max} is then made equal to 33,000.

Several items have to be computed before entering the chart.

$$s = \frac{35.0}{9.71} = 3.60 \qquad \frac{L}{r} = \frac{462}{4.20} = 110$$

$$\frac{e}{s} = \frac{3.60}{3.60} = 1.0 \qquad \left(\frac{L}{r}\right)^2 = 12{,}100$$

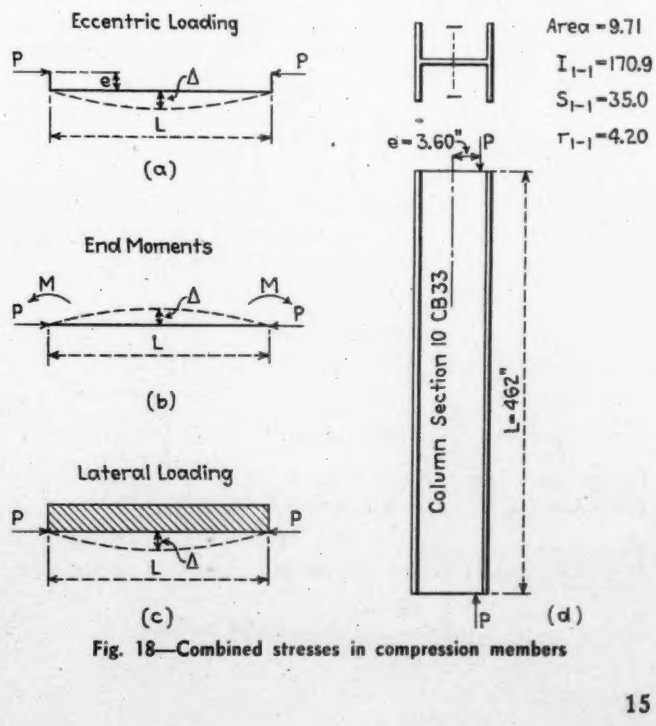


Fig. 18—Combined stresses in compression members

* Parts I and II of a previous paper by the same author, entitled Designing for High Tensile Steels, were published in the May and June, 1936, issues, respectively, of the *Railway Mechanical Engineer*. This paper was published in two parts, designated as Parts III and IV, Part III appearing in the December, 1939, issue and Part IV appearing in this issue.

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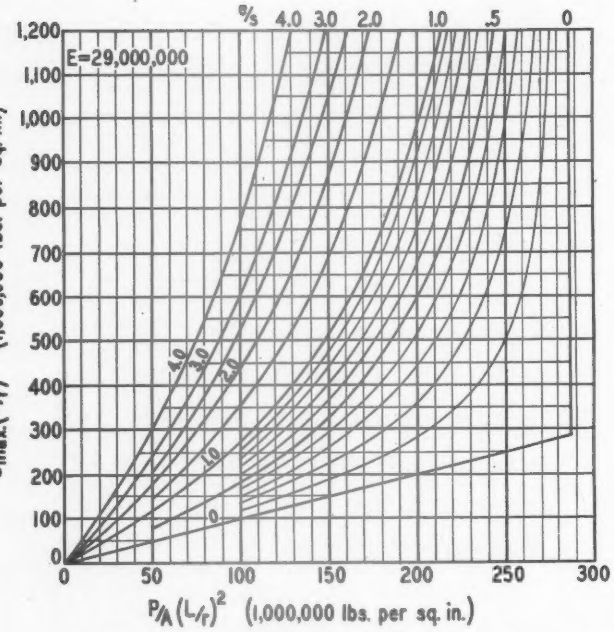


Fig. 19—Chart for designing eccentrically loaded compression members

$$S_{max}\left(\frac{L}{r}\right)^2 = 33{,}000 \times 12{,}100 = 400{,}000{,}000$$

Enter the chart at this value of S_{max} $(L/r)^2$ and follow horizontally across to the sloping line for $e/s = 1.0$ and read the value of 130,000,000 for P/A $(L/r)^2$. Knowing the value of $(L/r)^2$ we obtain

$$\frac{P}{A} = \frac{130{,}000{,}000}{12{,}100} = 10{,}740 \text{ lb. per sq. in.}$$

$$A = 9.71 \text{ sq. in.}$$

therefore

$$P = 10{,}740 \times 9.71 = 104{,}300 \text{ lb.}$$

It should be remembered that this value of P is the ultimate load which the column can sustain without the combined unit stress exceeding the yield-point stress. The factor of safety must be applied to obtain the working load. With a factor of safety of 1.8, the working load becomes 57,940 lb.

In many cases the load on the column will be known and the designer will be interested in calculating the maximum stress. The chart in Fig. 20 will facilitate this solution. It is the graphical solution of the term

$$\left[\sec \frac{\pi}{2}\sqrt{\frac{P}{P_{cr}}}\right]$$

in Formula 56, designated by the letter N.

Let us use the same column as in Fig. 18 (d) and assume that the ultimate load P = 104,300 lb., as just found in the previous problem.

$$P_{cr} = \frac{\pi^2 \times 29{,}000{,}000 \times 170.9}{462 \times 462} = 229{,}200 \text{ lb.}$$

$$\frac{P}{P_{cr}} = \frac{104{,}300}{229{,}200} = .455$$

Enter the chart at this value of P/P_{cr} and follow vertically to the curve and read $N = 2.06$.

Then

Maximum moment = 2.06 × (104,300 × 3.60) = 773,500 in.-lb.

$$\frac{P}{A} = \frac{104{,}300}{9.71} = -10{,}740 \text{ lb. per sq. in.}$$

$$\frac{M}{S} = \frac{773{,}500}{35.0} = -22{,}100 \text{ lb. per sq. in.}$$

Total stress = — 32,840 lb. per sq. in.

This is in practical agreement with the value of S_{max} = 33,000 lb. per sq. in. which was assumed in the determination of the ultimate load P.

The reader will recognize in the formula for P_{cr} the well known Euler formula and some doubt may arise as to the validity of the formula for high values of P_{cr}. In this discussion of combined stresses P_{cr} is more in the nature of a mathematical constant and whatever its calculated value, that value is to be used in computing the ratio, P/P_{cr}.

Fig. 18 (b) is another illustration of combined compression and bending. The end moments M correspond precisely with the moments Pe and the solution of any problem is handled in the same manner just discussed. The chart in Fig. 20 may be used to advantage. It will also be found helpful in dealing with compression members having some end fixity or continuity over supports.

Another common example is shown in Fig. 18 (c) in which the compression member supports a laterally applied load. The equation of the elastic line of such a member can become a very complicated one and it is not practical to attempt to cover a wide variety of cases. Two cases have been selected for discussion, first, because they are encountered in car construction and second, for the reason that they are common to many structural designs.

The first case deals with a uniformly distributed lateral load as shown in Fig. 21. In order to broaden the scope of the chart, provision has been made for distributing the load over a portion of the span or length of the column.

As was the case with Fig. 20, this chart gives a graphical solution of the constant N in the equation for the maximum moment.

$$\text{Maximum moment} = N\, w\, L^2 \quad (59)$$

When the full span is laterally loaded, it is evident that maximum moment and deflection will occur at the

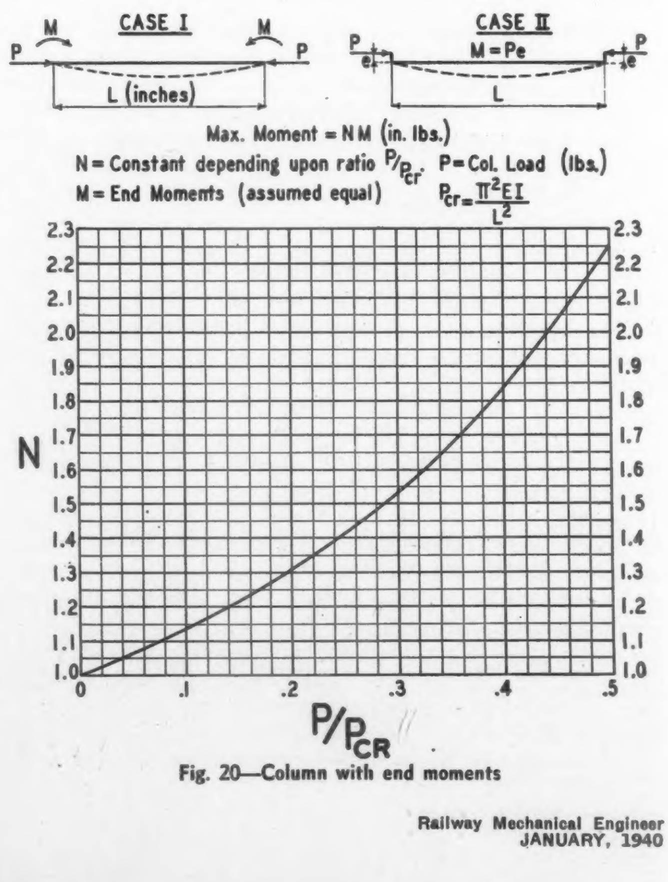


Fig. 20—Column with end moments

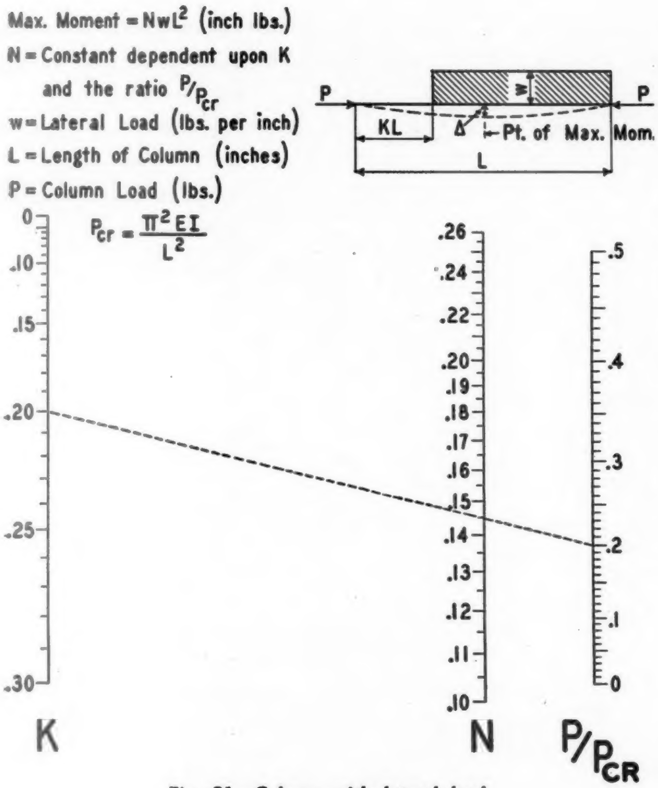


Fig. 21—Column with lateral load

center of the span. This is not true for partial loading, nor do the two points coincide. We are more interested in the point of maximum moment, which may move away from the center about .04 of the span length when $K = .3L$.

The moments produced by eccentricity and lateral load may be combined by addition, due care being exercised to observe the sign of each moment or the kind of stress they produce in a given portion of the member. The application of the charts in Figs. 20 and 21 will be illustrated by an example taken from the design of a compression chord in a pin-connected bridge.

Fig. 22 (a) shows the cross section of the chord member and gives the properties required for design purposes. The length between pins is 30 ft. Let the problem be the determination of the stresses in the chord for a direct compression load of 715,000 lb. and a lateral load of 200 lb. per ft., representing the dead weight of the chord with its details included. Assume that the line of action of the compression is on the center line of the web plates, thus having an eccentricity, $e = 1.112$ in., with respect to the neutral axis of the section. The loading is shown in Fig. 22 (b). The values for P_{cr} and the ratio of P/P_{cr} are also given.

Fig. 22 (c) treats the uniform lateral load, $w = 200/12 = 16.67$ lb. per in. acting with the direct load, $P = 715{,}000$ lb. The dotted line indicates the final position of the member and it is evident that the bending moment will produce compression in the top flange and tension in the bottom flange. The calculation of this moment depends upon the constant N in the equation $M = N\,w\,L^2$. Enter the chart in Fig. 21, lay a straight edge across the nomograph from $K = 0$ to $P/P_{cr} = .077$, and read $N = .136$. The maximum moment and the bending stresses in the flanges are as follows:

$$\text{Maximum moment} = .136 \times 16.67 \times 360 \times 360 = 293{,}800 \text{ in.-lb.}$$

$$\text{Stress in top flange} = \frac{293{,}800}{419.3} = -701 \text{ lb. per sq. in.}$$

$$\text{Stress in bottom flanges} = \frac{293{,}800}{336.2} = +874 \text{ lb. per sq. in.}$$

The case of the eccentricity is shown in Fig. 22 (d). Since the load acts below the neutral axis, the member will be bent upward to the position of the dotted line, producing tension in the top flange and compression in the bottom flanges. From Fig. 20, the value of N is 1.10 for $P/P_{cr} = .077$. The maximum moment and the stresses in this case are

$$\text{Maximum moment} = 1.10 \times (715{,}000 \times 1.112) = 874{,}600 \text{ in.-lb.}$$

$$\text{Stress in top flange} = \frac{874{,}600}{419.3} = +2{,}086 \text{ lb. per sq. in.}$$

$$\text{Stress in bottom flanges} = \frac{874{,}600}{336.2} = -2{,}601 \text{ lb. per sq. in.}$$

$$\text{The direct stress } \frac{P}{A} = \frac{715{,}000}{52.94} = -13{,}506 \text{ lb. per sq. in.}$$

Summarizing the stresses

	Stress in top flange, lb. per sq. in.	Stress in bottom flange, lb. per sq. in.
Direct	— 13,506	— 13,506
Uniform load	— 701	+ 874
Eccentricity	+ 2,086	— 2,601
Total stress	— 12,121	— 15,233

in which the minus sign denotes compression and the plus sign denotes tension.

The second type of lateral load is the triangular, or uniformly varying, distribution as shown in Fig. 23. The scope of the diagram has been extended by the provision for the loading to extend over a portion of the span as was done for the uniform load. The operation of the nomographic chart is identical with that already explained for Fig. 21.

The maximum moment occurs at a point about .58 L from the left-hand end when $K = 0$ and at .61 L for $K = 0.3$. It will be evident that adding the moment, obtained from the chart in Fig. 23, to moments due to eccentricity or uniform lateral load will be on the safe side since the latter moments may be reduced not over 5 per cent at a point .61 L from the left-hand support.

An illustrative problem, setting forth the use of several of the charts and formulas, is given in Fig. 24. Let

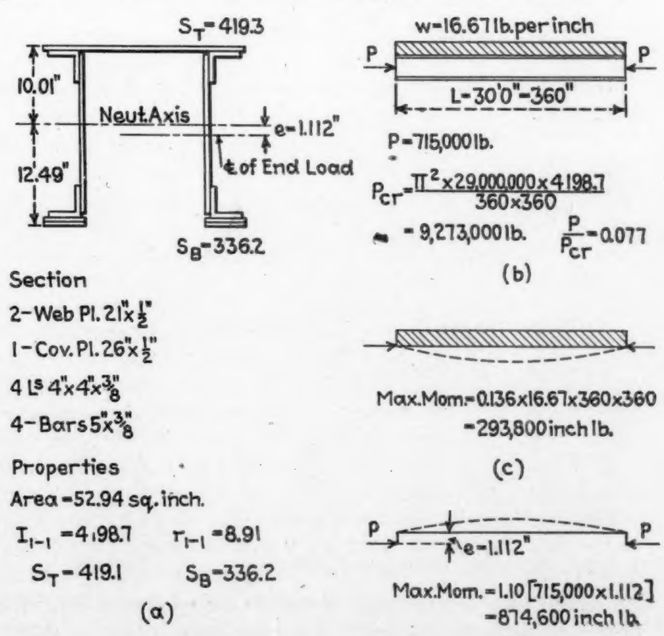


Fig. 22—Combined stresses in bridge chord

it be the problem to determine whether the laterally loaded strut has a factor of safety of 1.8 when made of a steel having a yield point of 50,000 lb. per sq. in.

The cross-section of the strut was selected with a dimension of 6¼ in. between the rivets or spot welds connecting the top cover to the flanges of the channel section. This dimension provides an illustration of the effective width of cover to be included with the channel section.

Referring to Fig. 15

$$2W_2 = 1.70 \times .125 \sqrt{\frac{29{,}000{,}000}{50{,}000}} = 5.12 \text{ (5⅛ in.)}$$

therefore, a portion of the cover plate at the center 1⅛ in. long (6¼ — 5⅛) is considered as ineffective and was neglected in calculating the properties of the strut section given in Fig. 24.

The first step is to multiply the end and lateral loads by the factor of safety of 1.8, as indicated on the sketch. Then the value of the critical end load, P_{cr}, should be computed and the ratio of the actual end load to the critical end load should be determined. The calculations of these two quantities is shown on the sketch.

Direct load—The direct unit compressive stress equals the end load divided by the area:

$$\frac{P}{A} = \frac{27{,}000}{3.40} = -7{,}940 \text{ lb. per sq. in.}$$

End eccentricity—From the chart in Fig. 20:

$$\frac{P}{P_{cr}} = .279 \qquad N = 1.48$$

$$M = 1.48 \times 27{,}000 \times 1.372 = 54{,}830 \text{ in.-lb.}$$

$$\text{Top flange } f = \frac{54{,}830}{4.69} = -11{,}690 \text{ lb. per sq. in.}$$

$$\text{Bottom flange } f = \frac{54{,}830}{3.30} = +16{,}620 \text{ lb. per sq. in.}$$

Uniform lateral load—From the chart in Fig. 21:

$$\frac{P}{P_{cr}} = .279 \qquad K = 0$$

$$N = .175 \qquad M = .175 \times 16.2 \times (144)^2 = 58{,}790 \text{ in.-lb.}$$

$$\text{Top flange } f = \frac{58{,}790}{4.69} = -12{,}530 \text{ lb. per sq. in.}$$

$$\text{Bottom flange } f = \frac{58{,}790}{3.30} = +17{,}810 \text{ lb. per sq. in.}$$

Uniformly varying lateral load—From the chart in Fig. 23:

$$\frac{P}{P_{cr}} = .279 \qquad K = .25$$

$$N = .0478 \qquad M = .0478 \times .54 \times (144)^3 = 77{,}070 \text{ in.-lb.}$$

$$\text{Top flange } f = \frac{77{,}070}{4.69} = -16{,}430 \text{ lb. per sq. in.}$$

$$\text{Bottom flange } f = \frac{77{,}070}{3.30} = +23{,}360 \text{ lb. per sq. in.}$$

Summary of stresses—

	Stress in top flange, lb. per sq. in.	Stress in bottom flange, lb. per sq. in.
Direct load	— 7,940	— 7,940
End eccentricity	— 11,690	+ 16,620
Uniform lateral load	— 12,530	+ 17,810
Varying lateral load	— 16,430	+ 23,360
Total combined stress	— 48,590	+ 49,850

in which the minus sign denotes compression and the plus sign denotes tension. The combined stress in either flange does not exceed the yield-point of 50,000 lb. per sq. in., hence the strut has a factor of safety of at least

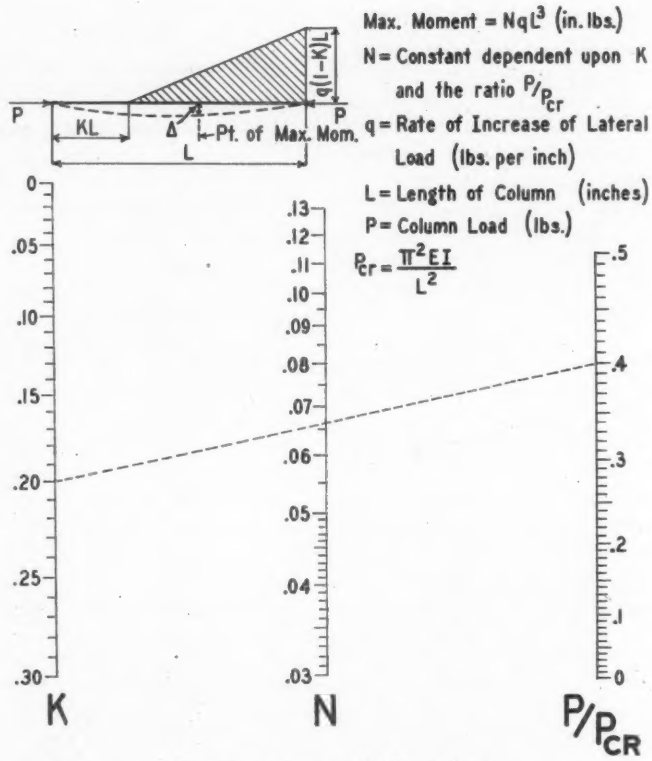


Fig. 23—Column with lateral load

1.8 with the assumed loading conditions.

Conclusion

The subject of elastic instability, or buckling strength, is one that is under active experimental and theoretical investigation. An engineer must still use judgment in the application of the formulas so far proposed for the solution of designing problems. It is believed that the data in this paper will provide a working basis for meeting many present day problems in a safe and satisfactory manner and enable engineers to proceed with assurance in a field where much remains to be studied.

Appendix—Post Office Department Specification

The specification for the construction of full and apartment railway post office cars, revised to July 20, 1938, contains provisions covering the buckling stability of any flat surface under compression in its plane. It seems

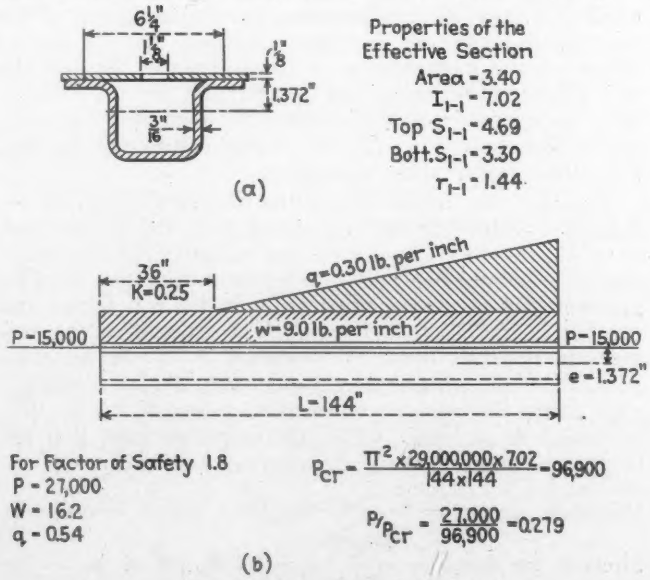


Fig. 24—Laterally loaded strut

appropriate, therefore, to add an appendix to this paper in which a set of working formulas, based upon the specification, can be presented as in Fig. 25.

The following excerpts are taken from Section 24 (Stresses) of the specification:

"Axial compression stresses in members, or elements of members, must not exceed those allowed by the following column and stability formulas:

For $\frac{L}{r} \leqq \pi \sqrt{\frac{2E'}{F}}$

Then $\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}\left(\frac{L}{r}\right)^2$, lb. per sq. in.

For $\frac{L}{r} > \pi \sqrt{\frac{2E'}{F}}$

Then $\frac{P}{A} = \frac{\pi^2 E'}{\left(\frac{L}{r}\right)^2}$, lb. per sq. in.

"These formulas give a nominal safety factor of 2.0 for reasonably restrained end condition.

in which L = Length of column, center to center of connections, in.
r = Least radius of gyration of column cross-section, in.
E' = Secant modulus of elasticity as derived from the tensile stress-strain diagram
F = Maximum allowable unit stress
P = Axial load, concentric, lb.
A = Area of column cross-section, sq. in.

"Stresses described above as maximum allowable are contingent upon the ability of webs and flanges to resist these stresses without buckling. For compression in the plane of any flat surface, this ability to resist buckling shall be determined by substituting the following equivalent slenderness ratios in the foregoing column formulas:

For outstanding flanges $\frac{L}{r} = 5.0\,\frac{b}{t}$

For other than outstanding flanges $\frac{L}{r} = 1.8\,\frac{b}{t}$

AXIAL COMPRESSION			
Yield Point	$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}(L/r)^2$	Validity Limit (L/r)	$\frac{P}{A} = \frac{\pi^2 E'}{(L/r)^2}$
32,000	$16{,}000 - .224\,(L/r)^2$	189.2	$\frac{286{,}220{,}000}{(L/r)^2}$
50,000	$25{,}000 - .546\,(L/r)^2$	151.3	$\frac{286{,}220{,}000}{(L/r)^2}$
COMPRESSION ON OUTSTANDING FLANGES			
Yield Point	$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}(5.0\,b/t)^2$	Validity Limit (b/t)	$\frac{P}{A} = \frac{\pi^2 E'}{(5.0\,b/t)^2}$
32,000	$16{,}000 - 5.59\,(b/t)^2$	37.8	$\frac{11{,}449{,}000}{(b/t)^2}$
50,000	$25{,}000 - 13.65\,(b/t)^2$	30.3	$\frac{11{,}449{,}000}{(b/t)^2}$
COMPRESSION ON OTHER THAN OUTSTANDING FLANGES			
Yield Point	$\frac{P}{A} = F - \frac{F^2}{4\pi^2 E'}(1.8\,b/t)^2$	Validity Limit (b/t)	$\frac{P}{A} = \frac{\pi^2 E'}{(1.8\,b/t)^2}$
32,000	$16{,}000 - .724\,(b/t)^2$	105.1	$\frac{88{,}340{,}000}{(b/t)^2}$
50,000	$25{,}000 - 1.769\,(b/t)^2$	84.1	$\frac{88{,}340{,}000}{(b/t)^2}$
$E' = 29{,}000{,}000$			

Fig. 25—Formulas for axial compression and buckling stability for steels having yield points of 32,000 and 50,000 lb. per sq. in.

in which b = Flat width at right angles to direction of stress, in.
t = Thickness, in."

The specification permits a direct unit stress in compression for side sills and framing members of $F = 16{,}000$ lb. per sq. in. for rolled mild open-hearth steel. For comparison purposes, the yield point of this steel is taken as 32,000 lb. per sq. in. A steel having a yield point of 50,000 lb. per sq. in. is permitted to have a working unit stress of $F = 16{,}000 \times 50{,}000/32{,}000 = 25{,}000$ lb. per sq. in.

Fig. 25 is a tabulation of the formulas for axial compression and buckling stability for steels having yield points of 32,000 and 50,000 lb. per sq. in. For lack of space, charts based upon these formulas have not been included, but can be readily prepared by designers who desire to construct their own diagrams.

Bureau of Safety Reports on "City of San Francisco" Wreck

(Continued from page 14)

them collapsed. An absence of intermediate stages of damage was noticeable; in cases of badly damaged material the state of damage was total collapse. One underframe indicated compression failure. There was but little damage in cases where the tight-lock couplers and articulated joints held. The only instance of telescoping was at the ninth unit; it became separated at its articulated joint and the shank of the tight-lock coupler at the opposite end failed. The greatest damage sustained by the cars collectively consisted of failure of the superstructures. The aluminum alloy metal in many cases tore loose from the rivets and was cut through in places where it had been dragged on the ballast; very few steel rivets were sheared off. There was no indication of dispersion of strain; in many instances a badly torn section was adjacent to a section which had not buckled in the slightest degree. In many instances the tie straps between center-sill flanges were buckled.

Discussion

When the power units became derailed on the curve, the first power unit traveled to the left a few inches, because of following a tangential line; however, the motor housings and the pedestal binder-bolts prevented the power unit from leaving the roadbed.

The cars involved in this accident were constructed, for the most part, of aluminum alloy. As shown by the records, these cars were designed and constructed in accordance with the requirements of the Post Office Department specifications for railway mail cars; the underframes were designed to withstand a buffing stress of 400,000 pounds. The Postal Department specifications require a safety factor of two in the calculation of buffing stresses, fixing the minimum for actual failure because of buffing stock at 800,000 lb. To determine that the requirements of these specifications were complied with, the manufacturer apparently relied upon calculations and results of tests of a section of underframe similar to that of the cars in the "City of San Francisco." This section was 7 ft. 10 in. in length and withstood a compression test of 880,000 lb. before permanent deformation occurred. After the accident, on September 17, 1939, similar tests were made at the Pullman Car Manufacturing Co. laboratory; a section of frame removed from the car "Twin Peaks" was used and the

results indicated that the material was in accordance with the specifications.

On October 3, 1939, The Aluminum Co. of America, at its laboratory, conducted tests on a portion of the center-sill removed from the car "Twin Peaks," the ninth unit, using a piece near the point where a fracture had occurred. The results of this test demonstrated that the material was well above the minimum requirements.

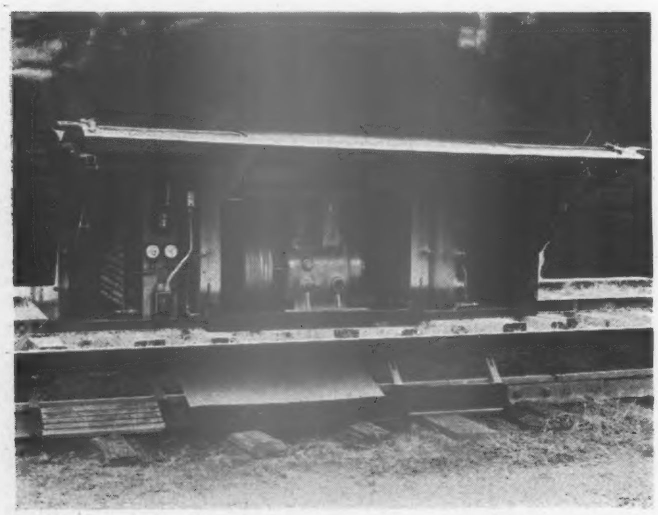
These cars withstood impact shock up to a certain degree, beyond which there was practically a total collapse; there appeared to be no intermediate stage of damage. A great amount of damage to the superstructures was sustained by the cars involved in this accident, especially those where the most fatalities occurred. The aluminum alloy sheathing, which forms a part of the girder construction of the car sides, manifested a tearing characteristic, in that the metal readily tore loose from the rivets; also it was cut and torn badly because of being dragged on the ballast. There was but little indication of dispersion of strain; in many instances a badly torn section was adjacent to one that did not buckle in the slightest degree.

Any attempt to draw conclusions as to what might have occurred had standard all-steel passenger cars been involved in this accident, would be purely conjectural and speculative.

D. & H. Lightweight Coaches

(*Continued from page 12*)

the Safety clutch on the G. E. equipment. The storage battery equipment consists of 50 cells of Edison batteries having a capacity of 510 amp. hr. at 64 volts. A novel feature of the battery compartment is the balanced door, which swings underneath when open, and no part of which comes closer than approximately 6½ in. to the



Air Conditioning compressor compartment

third rail in electrified yards. When the door is closed, its two ends form a baffle with the ends of the compartment to provide ventilation.

The air-conditioning equipment is electro-mechanical, of 7 tons capacity. Three cars have General Electric equipment and the other three have the Safety system. Interior temperatures are regulated by the Vapor correlative control. Supplementing the air-conditioning system are four fans behind bulkhead grilles exhausting to the atmosphere. These fans are for emergency use.

Luggage compartment adjacent to the men's room

Special attention was given the design of the toilet facilities to assure a departure from the conventional arrangement. All of the pipes and fittings have been concealed and the space under the wash stands has been enclosed thereby providing a receptacle for soiled towels.

Other Features of Equipment

The cars are well insulated to insure a comfortable temperature in all seasons, there being 2 in. of insulation in the roof, ends and sides, and 1-1½ in. in the floor.

Double glazed O. M. Edwards sash is used, the inner sash being hinged to facilitate economical window cleaning. Activated alumena is used between the sash to absorb any condensation or moisture which might collect. Further safety to the passengers is insured by the fact that ¼ in. safety glass is used in the inner sash.

Large parcel racks are provided, running the full length of the car. Supplementing these racks and located at the saloon end of the car is a spacious luggage locker for the heavier baggage. The ends doors are equipped with the Dayton push-pull type of door locks.

The four-wheel trucks under these cars have cast steel frames. The wheels are 36 in. diameter and are equipped with A. S. F. roller bearing units with SKF bearings. The wheels are carefully balanced and the treads are ground after mounting on the axles. The wheel pairs are then finally balanced to insure riding comfort. The trucks are equipped with Simplex unit cylinder clasp brakes and are insulated.

The cars are equipped with National tight lock couplers, New York Type HSC, Schedule D-22-A brake equipment and Miner friction draft gears and buffers.

EDITORIALS

"City of San Francisco" Wreck Report

The report of the Bureau of Safety on the wreck of the streamliner City of San Francisco, which occurred on the evening of August 12, noted in this issue, has been awaited with unusual interest because the principal materials of construction of the cars were strong alloys of aluminum, one of the several types of new structural materials which have made possible marked savings in the weights of passenger-train cars. The essential facts as far as the performance of the rolling stock in the wreck is concerned are that the train, moving westward, was derailed toward the outside of a long three-degree curve, 169.5 ft. east of a 120-ft. Warren truss bridge over the Humboldt river. As was inevitable, a portion of the train, which was moving at 60 m. p. h. at the time of the accident, came into violent contact with the bridge trusses, completely destroying the bridge and precipitating a number of the cars onto the river bed some 33 ft. below the track elevation, several of them entangling with the twisted members of the bridge trusses.

There is ample evidence in published photographs, taken at the scene before the wreckage had been disturbed, that there had been extremely violent contacts between some of the cars in the train and parts of the bridge structure. These violent blows began with the kitchen-diner unit of the two-unit articulated kitchen-dining car, the sixth unit in the train counting the three locomotive units. The front end of this unit is said to have collided with the west abutment with sufficient violence to displace the abutment 1½ in. against the backfill, a collision impact which, in view of the probable increasing misalignment of the derailed vehicles the farther they were from the front end of the train, would account for the evidence of violent change of direction of the four units immediately following, and the entanglement of some of them with the falling bridge structure. It would seem highly probable that the puncturing and flailing action of falling bridge members contributed materially to the destruction wrought on these cars. The only cars the structures of which were not intact after the wreck were the kitchen-diner unit and the three units following, and these are the cars which were involved in the wreck of the bridge. The fourth following unit, which fell on its side on top of the pile, shows no evidence of failure of the structure, except possible punctures of the side on which it lay.

The inspectors of the Bureau of Safety observed that "the cars withstood impact shock up to a certain degree, after which some of them collapsed. An absence of intermediate stages of damage was noticeable; in cases of badly damaged material the state of damage was total collapse. One underframe indicated compression failure." The discussion of the evidence at the conclusion of the report contains the statement that "A great amount of damage to the superstructures was sustained by the cars involved in this accident, especially those where the most fatalities occurred. The aluminum-alloy sheathing which forms a part of the girder construction of the car sides, manifested a tearing characteristic in that the metal readily tore loose from the rivets; also, it was cut and torn badly because of being dragged on the ballast. There was but little indication of dispersion of strain; in many instances a badly torn section was adjacent to one which had not buckled in the slightest degree."

The major portion of the report on this wreck is devoted to establishing beyond peradventure of a doubt that the derailment of the train was caused by the deliberate misalignment of a rail on the outside of the curve. Nine and three-quarter pages of the report are devoted to the presentation of this evidence. Considering the importance of establishing this fact, such care is highly commendable. In view of the fact that this is the first serious wreck of a train made up of vehicles of aluminum-alloy construction and that it has attracted widespread public attention partly for that reason, it would seem that equally meticulous efforts would have been justified in presenting all the facts and evidence bearing upon the probable forces to which the damaged cars were subjected to correlate with the observations in the report bearing on the behavior of the material of which they were built. For instance, is it not important to know the direction from and the time interval within which the forces were applied in order to evaluate the apparent absence of "dispersion of strain" and the extensive damage to the superstructures of the cars involved with the bridge? Again, what is the significance of the statement that "the aluminum-alloy sheathing which forms a part of the girder construction of the car sides manifested a tearing characteristic in that the metal readily tore loose from the rivets" unless the evidence includes the facts concerning the crushing and shearing strength of the rivets as well as the crushing and shearing strength of the material of the sheets?

Such facts concerning the performance of the equipment as are contained in the report and in published photographs of the wreck suggest that these cars were subjected to forces beyond those for the resistance of which it is practicable to design passenger cars and that some of these forces at least were applied in directions not anticipated in the design of any passenger cars. Therefore, failures were inevitable. In view of the absence from the reports of facts on which the inspectors based their observations, it seems unfortunate that

the comment in the report on this aspect of the wreck was not confined to the closing statement that "any attempt to draw conclusions as to what might have occurred had standard all-steel passenger cars been involved in this accident would be purely conjectural and speculative."

Steam and Diesel Locomotive Comparisons

In statements comparing the performance and costs of operation of Diesel-electric locomotives with steam locomotives the steam locomotive as a type is almost always placed at an unfair disadvantage because the comparison is made between the proposed new Diesel locomotive and whatever steam locomotives happen to be performing the service at the time. The question "what would be the results if the most modern steam locomotives were to be considered for this service" seems seldom to be asked.

There are at least three aspects of such comparisons which cannot safely be passed over without careful consideration of both types of motive power on a basis of equality as far as the modern character of the design is concerned. First is the question of fuel cost. It may make a considerable difference in the results whether the cost of coal required to perform a given service is based on a thermal efficiency of three or four per cent or whether it is based on six or seven per cent. Then there is the question of the horsepower-weight ratio. Steam passenger locomotives are in service today with a gross weight of engine and tender of as low as 130 lb. per hp. and there are a number of them in service with weights around 150 lb. per hp. Advantage in this respect, therefore, lies with the Diesel-electric locomotive only where the comparison is made with the older or less well proportioned steam locomotives.

Another element of locomotive operating cost is the cost of maintenance. Here it is equally important that the performance of modern steam motive power be used in such comparisons. Older locomotives which during their life have been required to perform services faster and heavier than those for which they were originally built are far from showing the best economy in maintenance cost of which steam motive power is capable.

It is not the intention to imply that Diesel-electric motive power has not given an excellent account of itself. This fact is well established in switching service and is also being established in long distance passenger runs. In the latter case, however, the considerations leading to the decisions in favor of Diesel-electric locomotives have included factors not strictly of an economic character. There has been the element of glamour which, in some cases at least, has been weighted heavily in favor of the Diesel. In considering this factor, itself, however, the comparison has generally been with existing steam locomotives. New steam locomotives in the design of which style factors have been considered have also been notably effective in this respect.

It is important, therefore, from whatever aspect the comparison is viewed that the steam locomotive, modern in proportions as well as in style, represent the type in the competition with the Diesel-electric locomotives. Only in this way can there be any assurance that the best solution for each situation will be effected.

Should Old Cars Be Modernized?

The marked decrease in programs for the installation of air conditioning equipment in existing passenger cars during the past year would indicate, at first thought, that the roads are reaching a point where the major portion of such railroad-owned main-line equipment has been modernized in that respect. There is, however, another important factor which may have, or at least should have, an influence on further expenditures along that line. That factor is the question as to the economic advantages of expenditures for the modernization of old cars.

Disregarding entirely the influence of lower passenger fares on increases in passenger travel, the experience of the roads during the past three or four years has definitely proved that business has been attracted to the railroads by the expenditures that have been made for air conditioning. The trend to modern lightweight cars has provided an impetus to the recapture of a substantial amount of passenger travel. In all fairness it should be said that the most popular trains have been those that have been operated on greatly accelerated schedules and on roads operating such lightweight high-speed trains the experience has been that the traveling public prefers those trains to trains operating with standard equipment, even though the standard equipment may be air conditioned or otherwise modernized. On roads where no new lightweight high-speed trains are being operated in competition with standard equipment, the public has shown a definite preference for the modernized cars and there are indications that business might be increased with new equipment.

From an operating standpoint there are definite advantages in the lighter equipment. Without becoming involved in detailed cost figures, it probably will be conceded that lighter trains present certain advantages and possible economies. From the standpoint of the patron they are much more attractive and more comfortable to ride on.

From an operating standpoint there are economies such as the ability to haul more cars per train with a given amount of power. As an example, a ten-car train of the new lightweight coaches weighs no more than a seven-car train of the type of equipment built 20 years ago and, particularly at high speeds, it offers the advantage of a decidedly lower wind resistance. The

lighter cars, due to their weight advantage and better truck and brake equipment, can be started easier, accelerated more rapidly and stopped in shorter distances. Because of better insulation and more efficient heating systems the problem of heating in cold climates has been simplified and has resulted in economies.

We have now had sufficient experience in this country with the new equipment to suggest that the time has arrived when any program involving substantial expenditures for the modernization of old equipment should be very carefully weighed against the operating economies of new equipment plus the potentialities of increased passenger business because of the installation of such new equipment.

Fifteen Years of Diesel Progress

The close of the year 1939 witnessed the end of a period of 15 years since the Diesel-electric locomotive first was placed in active service on a railroad in the United States. Several interesting facts in connection with the installation of this type of power are worthy of mention.

The Diesel-electric first took its place in the switching field and, from the beginning, has continued to make rapid and substantial progress. Ten years went by before the first road locomotive was placed in active main-line service in 1935 and by that time 113 switchers, having an aggregate of 47,600 engine-horsepower, were doing their regular turn of duty.

It is interesting to note, at this point, that in 1925, when the first Diesel-electric unit went into regular service on the Central Railroad of New Jersey, there were 10,702 steam switching locomotives on Class I roads having an aggregate of 361 million pounds tractive force. During the five-year period from 1925 to 1929, inclusive, the ownership decreased by 286 units while 729 new steam switchers were ordered. In the next five-year period, from 1930 to 1934, inclusive, the ownership of steam switchers decreased by 1,704 more while only 118 new units were ordered. Thus in 10 years the ownership of steam switchers decreased by almost 2,000 during a period when the Diesel-electric was coming into the railroad picture.

At the end of 1934 there were 8,712 steam switching locomotives in railroad service and, as previously stated 113 Diesel-electrics has been placed in service. By the end of 1939 the number of steam switchers had decreased by 1,088 more to a total of 7,624 while the number of Diesel-electrics had increased to a total of 601. The total engine horsepower of the Diesel engines in switching-locomotive service was 397,380 at the end of 1939. The orders for steam switchers during the same five-year period totalled 93.

During the five-year period from 1935 to 1939 inclusive the Diesel-electric locomotive not only continued its invasion of the switching field but it also entered road service in the handling of the high-speed trains.

The installations of Diesel-electric passenger locomotives during the last five-year period totalled 73 units having an aggregate of 178,700 Diesel-engine horsepower.

The average switching locomotive horsepower in the first five-year period was 450; this had increased to an average of 630 for the latest five-year period.

The figures do not include Diesel engines in rail-cars.

New Books

ENGINEERING OPPORTUNITIES. *Published by D. Appleton-Century Company, New York. 400 pages, illustrated. Price, $3.*

"Engineering Opportunities," edited by R. W. Clyne, is a non-technical survey of engineering activities in industry. It is intended to assist young men who contemplate entering the field of professional engineering, as well as engineering students who need advice on choosing the particular business in which to apply their technical training, and shows some of the opportunities which exist today in such fields as the aluminum industry, Diesel power, electrical manufacturing, metallurgy, railway equipment, refrigeration and air conditioning, mechanical vibrations, etc. Each of the twenty-six chapters has been written by an engineer who endeavors to show the background of the industry in which he is an expert, the present condition of affairs, and the possibilities for the future. Among the authors are S. K. Colby, vice-president, Aluminum Company of America; James Shelby Thomas, president, Chrysler Institute of Engineering, Detroit, and Clarkson College of Technology, Potsdam, N. Y.; T. C. Johnson, General Electric Company, Schenectady, N. Y.; Edmund Q. Sylvester, research engineer, American Steel Foundries, and L. K. Sillcox, first vice-president, New York Air Brake Company.

DIESEL ENGINES. *By B. J. von Bongart. Published by D. Van Nostrand Co., Inc., New York. 335 pages, illustrated. Price $4.00.*

This book is designed primarily as a text for the study of internal combustion engines of the Diesel or compression-ignition type, but is also useful to the layman who wishes to become familiar with this prime mover. After a brief history of the Diesel engine, the author discusses thermodynamics, combustion and combustion-chamber design, fuel oils, fuel atomization, fuel pumps, and injection systems. Research work, especially that relating to fuel atomization, combustion, and combustion-chamber design, is summarized. Examples of the various types of Diesel engine construction are reviewed in detail. These include aircraft, automotive, marine, and locomotive Diesels, which are representative of modern practice, particularly those in the medium- and high-speed field. A study is also made of design features in which the author points out desirable and undesirable characteristics.

IN THE BACK SHOP AND ENGINEHOUSE

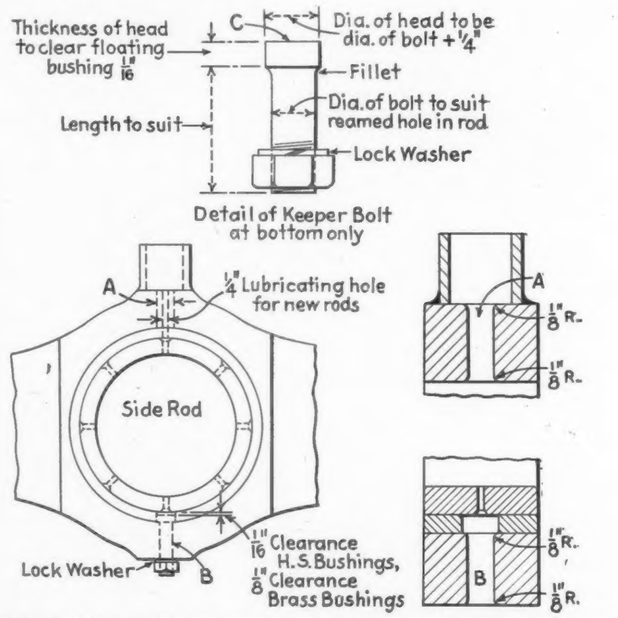
Two Safety Features In Rod Design

For modern high-speed locomotive operation, there is a strong urge to make the valve-motion parts and particularly the pistons, piston rods, crossheads and driving rods just as light in weight as possible, consistent with the requisite strength. With highly stressed steel, often containing a high percentage of various alloys, experience has demonstrated time and again the absolute necessity of utilizing rounded corners, generous fillets and highly polished surfaces free of hairline cracks, hammer marks, accidental contact with either the electric or gas-welding torch, or in fact, any surface defect which may lead to progressive fracture and failure of the steel.

With a view to securing maximum reliability in the service of locomotive driving rods, for example, it is now considered questionable practice to cut threads in any part of the rod structure. Even threaded lubricator plug holes or keeper stud holes are looked on as possible points of danger, and a means successfully used on the Chicago, Rock Island & Pacific, for avoiding the use of threads at these two points in both main and side rods is shown in one of the illustrations. The other illustration shows a very simple but effective device, which gives positive assurance that the taper key cannot be lost out of side-rod knuckle pins and this design contributes to safety in high-speed operation.

Referring to the first drawing mentioned, the lubricating hole *A* which was originally tapped, is simply reamed out enough to remove all threads and leave a smooth inside surface with the upper and lower edges of the hole rounded to ⅛-in radii, as shown. On new rods of this type the lubricating hole is made smaller, being only ¼ in. in diameter and also having rounded edges at the top and bottom.

In the bottom of the intermediate side rod and also in the bottom of the solid back-end main rod, reference to the drawing will show that the threaded hole *B* is reamed to a smooth hole, the edges rounded to ⅛-in. radii and a keeper bolt *C* applied from the inside, with a cylindrical head positioning the bushing and a lock washer and

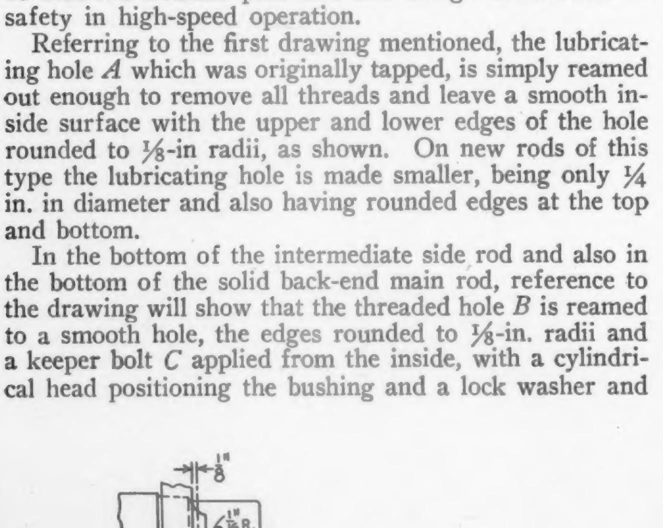


Detail of side-rod lubricating hole and keeper bolt without threaded connection in the rod

hex head nut on the outside, holding the bolt securely in place. The hole in the bushing which accommodates the head of this keeper bolt is drilled ¼ in. larger in diameter than the reamed hole and the head of the keeper bolt is machined to fit accurately in the bushing hole, with a clearance of 1/16 in. under Hunt-Spiller bushings, or ⅛ in. under brass bushings. The keeper bolt is made a very light drive fit in the reamed hole *B*, the length of the bolt being made to suit the thickness of the rod at this point with just enough additional length to accommodate the lock washer and hex nut.

Referring to the knuckle-pin drawing, it will be observed that in this instance the taper holding key is 8 in. long and has a taper of ¾ in. in 12 in. In applying this knuckle pin, a draw key is used to pull the knuckle pin in place, then being removed and replaced with the taper key illustrated. It was formerly the practice to drill a hole where the narrow part of the tapered key projects through the knuckle pin and apply and spread a cotter pin which presumably would hold the key permanently in place. In actual practice, however, it was found that the taper key sometimes became loose, the cotter worked out or was sheared off and in at least one instance, the taper key itself broke inside the knuckle pin, allowing the lower portion with the cotter to drop out and permitting the upper part of the key also to become dislodged and cause a rod failure.

A simple expedient to overcome this difficulty consists of inserting the ⅜ in. diameter rod lock through the upper hole in the taper key, bending the rod around the knuckle pin and passing it through the lower cotter pin hole, and bending over each end of the rod lock as shown in the drawing. A substantial lock for the key is thus provided which cannot work loose or shear off and in the event of breakage of the taper key inside the knuckle pin, the two parts of the key will actually be held in place until the locomotive reaches the shop and suitable repairs can be made.



Knuckle-pin taper key securely held in place by a ⅜-in. diameter rod lock

About Press Fits

By A. D. Hollis

In spite of the large amount of research and experiment that have been devoted to this subject new discoveries are often made and all is not known yet about press fits. For example, only a few years ago photo-elastic studies with polarized light showed that stresses were relieved by machining a groove around the hole that receives a forced-fit shaft. This practice has been tried with good results on locomotive crossheads. A groove about 3/8 in. deep and 3/4 in. wide (often smaller at the bottom) is cut in the crosshead face at the same time the hole is bored. The diameter of the inside of the groove is about 1 1/2 in. larger than the large end of the hole in the crosshead that receives the tapered piston-rod fit. In the past a great deal of trouble has been experienced with heat-treated piston rods developing small checks and cracks in the taper fit near the point where the rod enters the crosshead, often just inside the fit. These cracks propagate rapidly and eventually cause failure. It is believed that the groove mentioned will greatly increase the life of the rod.

Another interesting recent discovery (set forth in reports of the Timken tests) is that finishing axle wheel seats by rolling will lengthen the axle life by retarding the formation and propagation of fatigue cracks.

Good common sense is not a reliable guide in connection with press fits, but it has been observed that the fit allowance on axle fits is about .0015 in. for each inch of diameter and tonnage may be estimated at 10 tons for each thousandth tight (steel wheels). The tonnage for locomotive driving axles on different railroads ranges from 155 to 200 tons, depending on the diameter of the axle and local practice. The tonnage necessary to start the axle out of the fit after long service may be from 25 per cent to 300 per cent greater than the mounting tonnage. About .004 to .005 in. increase takes place in the wheel bore after a wheel is dismounted, and is greatest toward the inside of the wheel. The most abrupt taper is about 1 1/4 in. from the hub face. The axle diameter is not reduced due to abrasion of the wheel fit, and the axle wheel fit remains straight and round after being pressed out of the wheel. To get the specified tonnage on lightweight disk-type locomotive driving wheels, fit allowances up to .022 in. are necessary. This is .004 to .005 in. more than allowed on spoke wheels of usual hub section.

Boiled linseed oil mixed with white lead to the consistency of thin paint is the common lubricant for press fits, but some railroads use red mineral paint thinned with boiled linseed oil. Castor oil has been suggested for a lubricant for press fits. If the lubricant is allowed to stand several hours on the fit before mounting the tonnage will be reduced. Pressing out the axle and then pressing it in again may increase the tonnage. Cases have been known where workmen placed emery dust in the lubricant to increase the tonnage. Shrinking pins in wheel centers by the use of fire causes corrosion and often freezing of the pin in the wheel. Pressure up to 1000 tons on the ram will not start out some of these pins applied in enginehouses. Scoring is often caused by not properly squaring up the parts in mounting.

A shrinkage method using dry ice or liquid air, and heating the wheel with steam has promising possibilities. A similar method is used in connection with the manufacture of ordnance.

One of the largest railroad systems uses a step fit on main crank pins. This permits entering the pin freely half way in the hole and is some help in aligning the eccentric crank keyway as on a full length press fit it may swing around slightly. With a step fit there is less abrasion and a better fit is secured. Step fits on pins and axles have not been generally adopted, but railroad mechanics are familiar with the step fit (sometimes triple fit) used on cylinder bushings.

Locomotive Boiler Questions and Answers

By George M. Davies

(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)

Calculating the Area Supported by Staybolts

Q.—Does the method of determining the diameter, and area supported by a hollow rigid staybolt also apply to a hollow flexible staybolt?—F. R. J.

A.—The area supported by either a hollow rigid or a hollow flexible staybolt is computed from the same formulas, the differences in the construction of the staybolts does not affect their respective holding powers.

Determine the maximum pitch of water space staybolts by the two methods given below and use the minimum valve thus obtained.

(a) Do not exceed a maximum stress of 7,500 lb. per sq. in. of net area, when staybolts are made of iron. In calculating the stress use the supported area less the area of the staybolt at the root of the thread, multiply by the maximum pressure for which the boiler is designed, and divide by the net area of the staybolt. The net area of the staybolt means least cross-sectional area at any part, usually at the root of the threads less the area of the telltale hole, but may be at the center in case it is reduced below the bottom of the thread.

(b) Do not exceed the maximum pitch as provided in the following A. S. M. E. Boiler Code Formula:

$$P = C \times T^2/p^2 .$$

where P = maximum allowable working pressure, lb. per sq. in., C = 125 for plates 7/16 in. thick and under, and 135 for plates over 7/16 in. thick, T = thickness of plate in sixteenth of an inch, and p = maximum pitch, in inches.

Suppose we have given a hollow rigid staybolt of 1 in. body diameter, 1 1/16 in. end diameter, 12 U. S. F. threads per inch and 7/32 in. telltale hole diameter. Also, a hollow flexible staybolt of 1 in. body diameter, 1 1/16 in. diameter end, 12 U. S. F. threads per inch, and 7/32 in. telltale hole diameter with 1 3/8 in. diameter head, and suitable sleeve and cap. The thickness of the firebox sheet is 7/16 in., and the maximum boiler pressure is 250 lb. per sq. in.

Substituting in (a) for either type staybolt we have the net cross-sectional area of the staybolt through the body, minus the area of the telltale hole = .7479 sq. in., net cross-section area of the staybolt at the root of the thread, minus the area of the telltale hole = 0.6775 sq. in.

The load carried by one staybolt is $0.6775 \times 7{,}500 = 5{,}181$ lb.

The area supported by one staybolt is $5{,}181 \div 250 = 20.7$ sq. in.

The total area supported by one staybolt is $20.7 + .7150 = 21.415$.

The maximum pitch of staybolts is $\sqrt{21.45} = 4.63$ in.

Substituting in (b) for either type of staybolt, we have:

$$P^2 = C \times T^2/P = 125 \times (7)^2/250 = 20.45$$

There, the maximum pitch of the staybolts $p = 4.52$ in.

From the above the maximum pitch of either the hollow rigid or the hollow flexible bolts would be 4.52 in. The diameter of the staybolt can be obtained from the formula in paragraph (*a*) when the working pressure and the pitch of the staybolts is known. The design of flexible staybolt sleeves is such that the cross-sectional area of the sleeve is always greater than the least cross-section area of the staybolt.

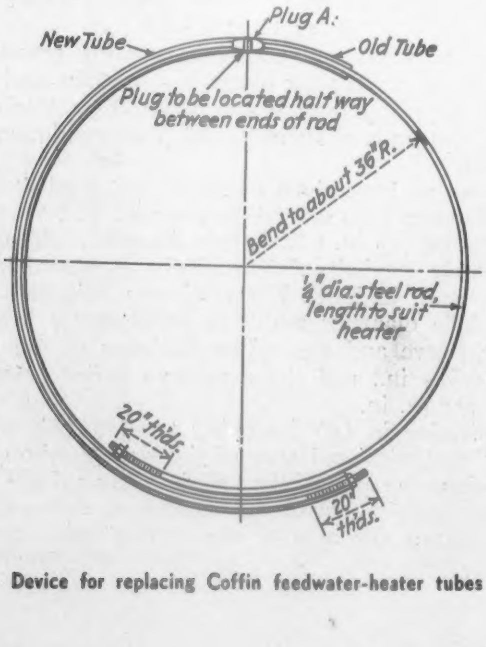
How to Renew Tubes in a Coffin Feedwater Heater

Q.—How are the tubes in a Coffin feedwater heater renewed? —M. T.

A.—The tubes in a Coffin feedwater heater are replaced by the use of the tube removing device shown in the drawing. It consists of a ¼-in. diameter rod, rolled to a 72-in. radius and of sufficient length to hold both the new and old tube. A stop or plug is welded on the rod at the middle, the outside diameter of the plug being made of sufficient diameter so as not to pass through the tube but small enough to pass through the tube-sheet hole.

To renew a tube, it should be drilled out of both tube sheets, after which one end of the tube remover is inserted in and threaded through the tube until it projects out at the opposite end. A nut is then applied on the protruding end. This nut is tightened until the stop on the tube remover is tight against the opposite end of the tube.

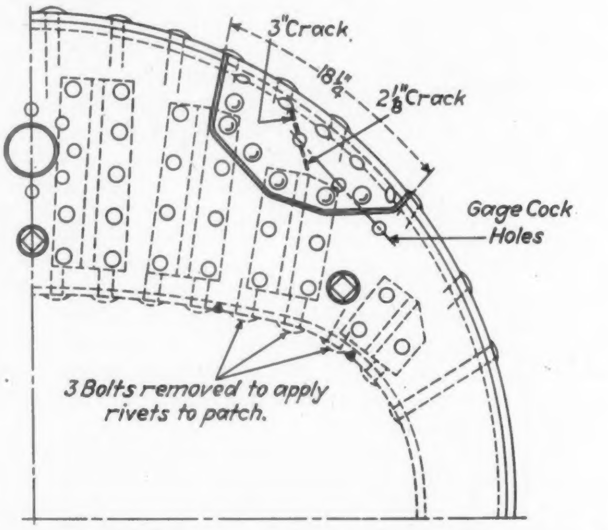
The opposite end of the tube remover is then inserted into the new tube in the same manner. The tube remover is notched until the old tube is removed and the new tube is in place. Afterwards remove the tube remover from the new tube and roll the tube ends into the tube sheets with a ½-in. tube expander.



Device for replacing Coffin feedwater-heater tubes

Boiler Patch Applied to Back Head*

The diagram shows the location of cracks which developed in the radius of the flange at the top of the back head of a locomotive. The cracks were electric welded after which a patch was applied as indicated on



A section of the crown sheet was removed to permit the holding of the rivets in applying this patch to the back head

the diagram. The patch was fabricated from ½-in. steel plate, riveted with ⅞-in. rivets, and electric welded to the outside wrapper sheet along the top of the boiler.

The application of this patch presented a problem which was solved in an economical manner. Instead of removing three rows of crown bolts the entire length of the firebox to permit the holding of the rivets from the inside, only the three crown bolts indicated on the diagram were removed. Then, a 4-in. by 12-in. section of the crown sheet was removed by use of a cutting torch. The patch being well above the crown sheet made it very difficult to hold the rivets through the small hole made in the crown sheet. A bar was designed especially to hold the rivets at the various angles. After the application of the patch was completed, another patch was welded in the opening in the crown sheet.

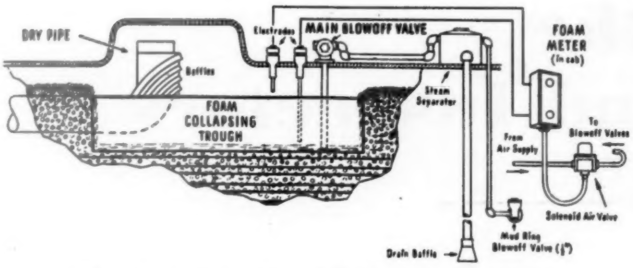
* An entry in the prize competition on boiler patches, announced in the March, 1939, issue. The names of the winners were published in the August, 1939, issue.

Automatic Blow-Off System

The Electromatic Foam-Collapsing blow-off system is designed to prevent the carrying over of water to locomotive cylinders and to reduce blow-down losses. It is a development of the Electro-Chemical Engineering Corporation, subsidiary of the Dearborn Chemical Company, Chicago.

The system utilizes: (1) A foam-collapsing trough which is mounted rigidly in the locomotive boiler directly under the dry-pipe intake; (2) a long electrode and a short electrode which project into the trough; (3) a solenoid valve; (4) a Foam-Meter; (5) two blow-off valves, and (6) a steam separator and drain.

When the boiler water expands to a dangerous point,



The Electromatic Foam-Collapsing blow-off system

it spills over into the trough. Here the foam is collapsed and the water in the trough makes contact with the long electrode. This lights the "safe" lamp on the Foam-Meter in the cab, and at the same time operates the solenoid valve which, in turn, opens both blow-off valves. Thus, the water in the trough, which contains a large proportion of the floated suspended matter, is blown down. Water and sludge are also blown from the mud ring through a smaller blow-off valve.

This system is designed to prevent water carry-over under practically all conditions by maintaining a clear steam passage to the dry pipe. It is said to prevent blow-off losses because it blows only when necessary, i. e., when the water expands to a dangerous level. It is fully automatic in operation and is designed so the engineman can always utilize the full steaming capacity of the boiler and will not have to ease off on the throttle or shorten the cut-off.

Spray Gun for Decorative Finishing

The type AG spray gun, a product of the DeVilbiss Company, Toledo, Ohio, supplies a range of service from the drawing of a fine pencil line to the laying of a broad soft spray and bridges the gap between the large artist's air brush and the small production or touch-up spray gun. It is especially suited for delicate tinting, fine stenciling, shading, blending, and high-lighting.


The DeVilbiss type AG spray gun

This spray gun is strongly built and at the same time is light in weight. It fits the hand easily, permitting the forefinger to rest naturally upon the trigger of the gun for ready control. It is available with a choice of three nozzle combinations which are adjustable for either round or spray applications. The gun offers a maximum spray width of three inches with accurate and simple control of both the width and density of the spray.

Whiting Drop Pit Table

The new Whiting 60-ton Type B drop-pit table has recently been installed on the Green Bay & Western, at Green Bay, Wis. The machine operates in a pit serving two active tracks with a release track between. A single shoulder pit serves one active track and the release track, with Whiting self-supporting swing gates for this active and release track. The remaining active track is not equipped with a shoulder pit or gates.

Each active track is equipped with a tabel top. Wheels may be dropped on either top and complete trucks may be dropped on the active track equipped with the shoulder pit and gates. All equipment dropped can be released at the releasing track.

The layout was arranged to handle individual pairs of wheels and complete trucks from steam and Diesel-electric locomotives, as the road uses both types of power.

Like other standard installations the space over the pit between the two table tops is equipped with a large platform spanning the pit. Unlike other installations, however, this particular platform is equipped with locking bars and pockets.

Before starting wheel-dropping operations, the machine is brought under this platform. After its bars are released it is lowered, moved under a table top and raised to nested position, as shown in the illustration. The load is lowered on the table top which, in turn, rests on the platform. After the load is racked sidewise, raised to the release track and wheels released, the top is brought back to its original position and the platform again locked in place between stalls.


Model B 60-ton drop-pit table with steel platform, usually located between table tops at ground level, nested against the table top

With the Car Foremen and Inspectors

Centralia Car-Shop Kinks

A railroad shop is known and its efficiency largely determined by the number and quality of labor-saving machines and devices which are used to reduce manual labor and expedite output. Shop kinks are just as important in car shops as in shops devoted to locomotive repairs, and a considerable number of those developed and used at the Illinois Central car shops, Centralia, Ill., are illustrated and described in the following pages.

Straightening Car Parts

Wherever possible, steel car parts which have been bent in service are straightened without removal from the car body, using pneumatic devices to save manual labor. For example, hopper-car doors which were formerly removed for repairs are now straightened in place using a quick-acting pneumatic jack under the center of one side sill to tip the car enough for a short steel bar to be placed between substantial blocking on the shop floor and the part of the hopper door which has been bent down due to excessive loading or damage from the clam-shell bucket. By lowering the air jack, the weight of the car body is used to press out the bulge and straighten the door, also closing all openings around the door except possibly a few which may be so large as to require individual attention.

This operation may be repeated almost as fast as the air jack can be operated and, as compared with the former method of removing the doors for straightening and then trying to fit them back up again, with hinges and fixtures somewhat out of alinement, a vast number of man hours of labor are saved every year.

Similarly, in the case of the bulged car ends, the end sheets can frequently be straightened in place by chaining the damaged car to another car with the coupler faces about 6 in. apart and using a double-acting air cylinder with special attachments to push against one car end while straightening the one which is bulged. In this operation, an 18-in. air cylinder is suspended from an overhead crane at the proper elevation between the cars. Both the moving piston rod and a rod of the same size, bolted to the pressure head of the air cylinder, have 24-in. swiveling steel bars on the ends, one being placed vertically against the straight car end to give a large bearing area and the other fitting in a horizontal corrugation of the damaged car end at the point of maximum bulge. One or more applications of air pressure are made, as necessary to straighten the end.

Referring to Fig. 1, a gantry crane and air-operated device for straightening the top rails of hopper and gondola cars will be seen. This gantry crane is a welded structure, made essentially of 9-in. channels, suitably braced and mounted on four 17-in. flanged wheels, thus being capable of movement on rails to any point desired along the car. The supporting rails are spaced 14 ft. on centers. The gantry is 14 ft. high, the spread of the wheels on each rail being 7 ft. 3 in., and a double 3-in. angle-iron runway at the top is equipped with one-ton chain falls which support the air-operated device used in straightening the top rails.

After a heavy-repair steel car has been stripped of defective plates and parts, the last operation before sending it to the sandblast position is to place it under the gantry crane, illustrated, for straightening the top rails. Small kinks are straightened cold, but, if too badly bent, the rails have to be heated slightly with a torch. The straightening device is a 12-in. air cylinder, equipped with a yoke on the pressure head and two hooks which are applied over the top rail, the air-cylinder piston rod contacting the top chord angle at the point of maximum deflection. Just enough pressure is applied in the air cylinder to remove this kink in the top chord angle, which is straightened progressively as needed by moving the gantry crane along the side of the car.

A satisfactory straightening job can thus be done without the expensive operation of removing, straightening and reassembling these parts. The hooks which reach over the top chord angle are provided with lips to prevent slipping and the steel block on the piston rod end is grooved to fit over the flange of the angle, thus holding the block in place while pressure is exerted against the web during the straightening operation.

In applying new sheets to steel cars, various types of lifting devices and special hooks are used to permit putting the sheets in place ready for riveting with a minimum amount of hand labor and with maximum

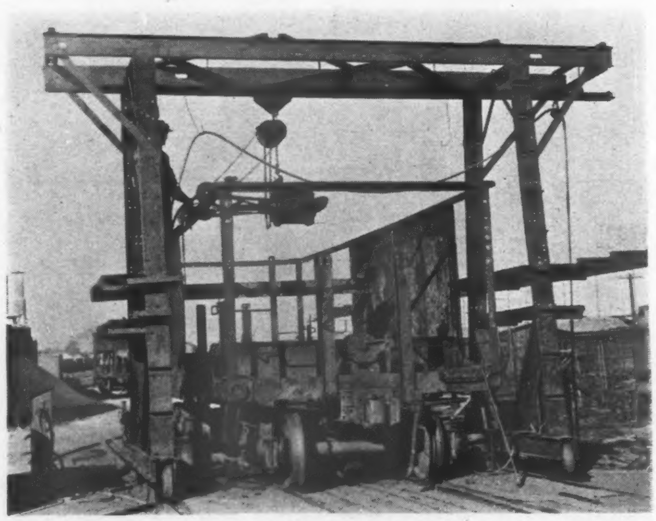


Fig. 1—Gantry crane equipped with air-operated device for straightening hopper-car top rails

safety. Two lifting hooks, illustrated in Fig. 2, are made of ½-in. by 3½-in. welded bars with the lower end of each vertical bar bent in the form of a flat hook to extend around the lower edge of the sheet and drilled with a hole through which a bolt may be applied to hold the sheet against slipping. The vertical bars are separated by substantial cross pieces and have chain connections at the top to a common ring which engages the crane hook. When lifted with the crane, this hook suspends the sheet above the center of gravity and hence it may be easily moved to the car, hoisted in place and holding bolts applied through the upper rivet holes without manual labor or the danger of pinched fingers.

Fig. 2—Lifting hooks used in applying steel car sheets of various shapes easily and safely

It will be noted that the lower lifting hook, shown in the illustration, is designed to assist in the application of rectangular sheets like the end sheets of a hopper car. The upper lifting hook is used in applying corner sheets which are irregular in shape and would be difficult to handle by any other means. If lifted by the crane with a chain connection to one of the upper rivet holes, for example, the chain would have to be released before the sheet could be finally pushed up in place by hand and holding bolts applied. The great advantage of these special hooks which permit lifting heavy sheets from the bottom by a crane is obvious.

Safe-Ending Hopper Car Doors

Almost every railroad shop man knows what is meant by safe-ending a boiler flue but how many realize that it is also possible to safe-end a hopper car door. In safe-ending boiler flues, defective ends are simply removed and new ends welded in place to give the flues another period of effective service. That is exactly the process involved in safe-ending hopper car doors as now practiced at the Centralia car shops. The lower edges

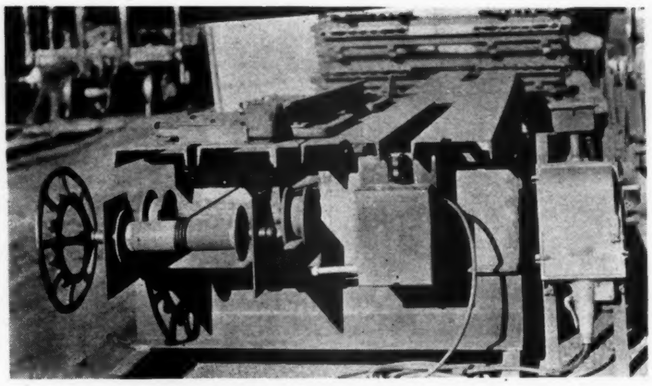


Fig. 3—Cold saw used in cutting off the worn ends of hopper-car doors preliminary to "safe-ending"

of the doors become eaten away by corrosion and mechanical wear until they are no longer tight and strong enough to carry a commodity load. Pressed-steel doors have a relatively short service life in this particular and even cast-steel doors show evidence of corrosion long before the car body is worn out.

When the practice of renewing these door ends was first instituted at Centralia, a section of the lower edge of each door about 3 in. wide was cut away, using an oxy-acetylene cutting torch. A new steel end was fabricated from a ¼-in. copper-steel plate, being made from a flat sheet of steel, flanged, cut out and welded at the corners so as to form a duplicate of the section of the door which was cut away. The difficulty with this method was that, even with the greatest care, a somewhat irregular edge was left by the cutting torch and in welding the new end back on the door, some difficulty was experienced. To overcome this trouble, a cold cut-off saw, shown in Figs. 3 and 4, was developed which performs the cutting operation in a fraction of the time formerly required and leaves a straight, smooth cutting edge to which it is easy to fit the new safe-end and weld it securely in place.

The cold saw consists essentially of a stationary table with a 24-in. metal-cutting saw mounted at the center and driven at a speed of approximately 1,200 r.p.m. by

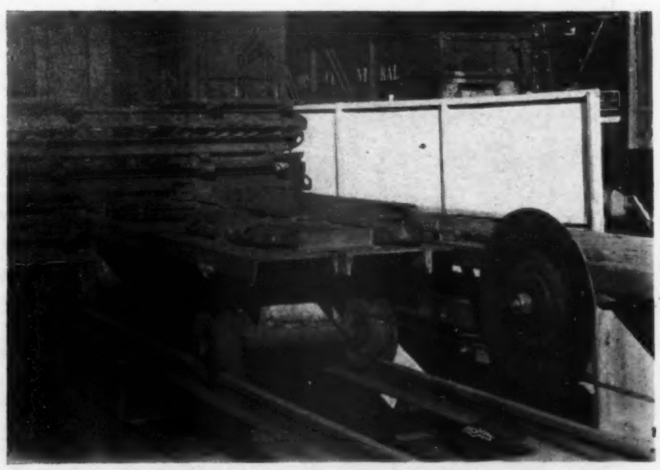


Fig. 4—Another view of the machine showing details of the door carriage and cut-off saw

belt drive from a 10-hp. motor mounted under the saw table. The saw blade is $^3/_{16}$ in. thick and the teeth in the outer periphery are designed to cut light sheet metal quickly and without excessive wear. The stationary

Fig. 5—Assembly lines in which new doors are fabricated and old doors equipped with new ends

table of the machine, best shown in Fig. 3, consists of two 12-in. by 20-ft. channels resting on and welded to four pairs of cross channels, the lower ones extending across the rails and being tack-welded to them. Two lengths of 90-lb. rail, 20 ft. long, rest on the lower channels and serve as a support for the traveling carriage which is mounted on wheels and arranged to support the hopper car door while being cut. The carriage is a welded steel structure comprising two 12-in. channels 10 ft. long, mounted on a frame which carries the roller wheels and equipped with positioning stops which hold the door both longitudinally and crosswise so that a straight cut will be taken 3 in. from the lower edge of the hopper-car door.

The carriage is traversed by means of an endless steel cable applied over an idler wheel and a 5-in. by 18-in. drum with hand wheel attachment as shown at the left in Fig. 3. Push-button control is provided for this machine and also a Pyle-National safety switch mounted on a portable steel framework as shown at the right. Referring to Fig. 4, a view of the machine is given with the door carriage at the extreme end of its travel after a cut has just been made.

Referring to Fig. 5, two assembly lines are shown inside the shop. The one at the left is used for fabricating new hopper-car doors and the line at the right for reconditioning old doors by applying new ends. Both of these assembly lines for car doors are placed opposite the position in the shop where hopper-car doors are applied and thus additional door handling is obviated with this arrangement.

In the operation of safe-ending, a new hopper door end, made of ¼-in. copper-bearing steel, is tack welded in place on each door down the entire length of the assembly line. One or more welders, as required, then complete the longitudinal welds using the electric process. The corners are formed by bending the ends 90 deg. and welding them to the doors which are then ready for

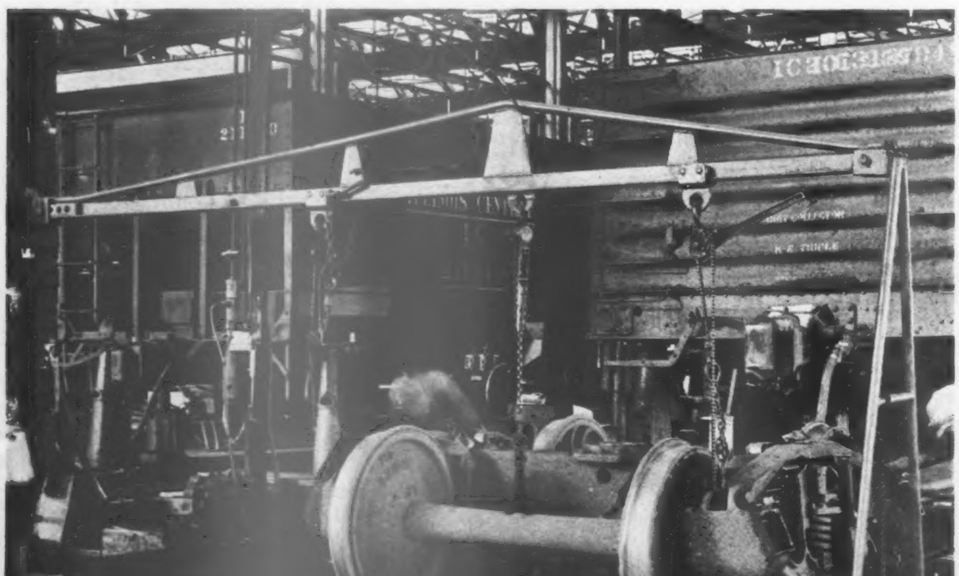


Fig. 6—Counterweighted truck-dismantling frame which may be swung upward against the vertical steel column when not in use

re-use with the probability that they will last throughout the life of the car.

Reduced Labor in Truck Work

Since truck repairs constitute an important part of car-shop work, every effort has been made to provide the special tools and equipment necessary for the expeditious handling of this work. A considerable number of frames for dismantling trucks, for example, are installed where needed throughout the shop, being in general of three types. The frame, illustrated in Fig. 6, is a light but well-braced beam, hinged to one of the steel building columns, having a hinged A-frame at the outer end and connected by a steel cable and pulley to a counterweight which operates vertically in the building column and permits easily swinging this dismantling frame up against the column when not in use. This type of dismantling frame is used adjacent to passageways where space is at a premium and crossovers must not be blocked. A somewhat less expensive dismantling frame, of the same general construction and also hinged to the building column, but arranged to swing horizontally parallel to the tracks is used where space is available.

The third type of truck-dismantling frame is a more or less permanently-positioned 8-in. I-beam which extends at an elevation of about 8 ft. high across the track at the major truck-repair station and does not have to be moved since this position is devoted exclusively to the repair of trucks and does not require the passage of cars along the track at any time. The beam is equipped, as usual, with three horizontally-adjustable hoists for handling the bolster and two side frames of a truck simultaneously. Such a permanent beam is shown in the background of Fig. 7.

In the foreground of this view is one of the large jib cranes, having a 19-ft. I-beam and equipped with a powerful and fast-operating air-hoist. An overhead electric hoist which travels on an 87-ft. I-beam across the heavy repair shop at this point provides means for transferring the trucks between the truck-repair position and any track on that side of the shop.

Referring again to Fig. 7, the special arrangement of crane hook used in lifting assembled trucks is shown. The construction of this steel frame with the four chains connecting to a single ring for attachment to the chain hook is clearly illustrated. A particular advantage of the device is that the four 1⅛-in. round bars which are bent in a half circle at the bottom for engagement with the car axles are hinged at the top so that when not in use they can be swung upward to a position slightly past the vertical while the frame is resting on the shop floor or being removed about the shop from one track to another. When positioned above the truck to be moved, the hooks are simply given a little push and swing down by gravity to the position shown in the illustration. Operation of the crane then lifts the truck without any possibility of the car brasses and wedges slipping out of position as is the case when ordinary chain hooks are used to engage the side frames or bolster.

Painting Underframes With Car Cement

When any attempt is made to spray car cement on the underframes of cars on the repair track, it is difficult, and in fact almost impossible, to reach all parts of the underframes, including inaccessible corners between the sills, bolsters, cross bearers, etc., unless the painter actually gets down on his hands and knees and crawls under the car. To permit doing a more thorough underneath-spraying job in less time, Centralia is equipped with two spray pits, one of which is shown in Fig. 8. This pit is 15 ft. wide by 61 ft. long and slightly over 5 ft. deep. The rails are carried across the pit on 18-in. I-beams, welded to supports which are made of 9-in. channels. A wooden platform on either side of the pit, 22 in. high enables the painter to work on two levels, whichever is easier, and access to the pit is had by means of steps at each end of each platform. A 3-in. angle-iron guard rail 28 in. high is provided on each side of the pit as a safety measure.

This pit, used for painting the under parts of all cars passing through the shop for heavy repairs, makes it easy to reach hitherto inaccessible places and do a

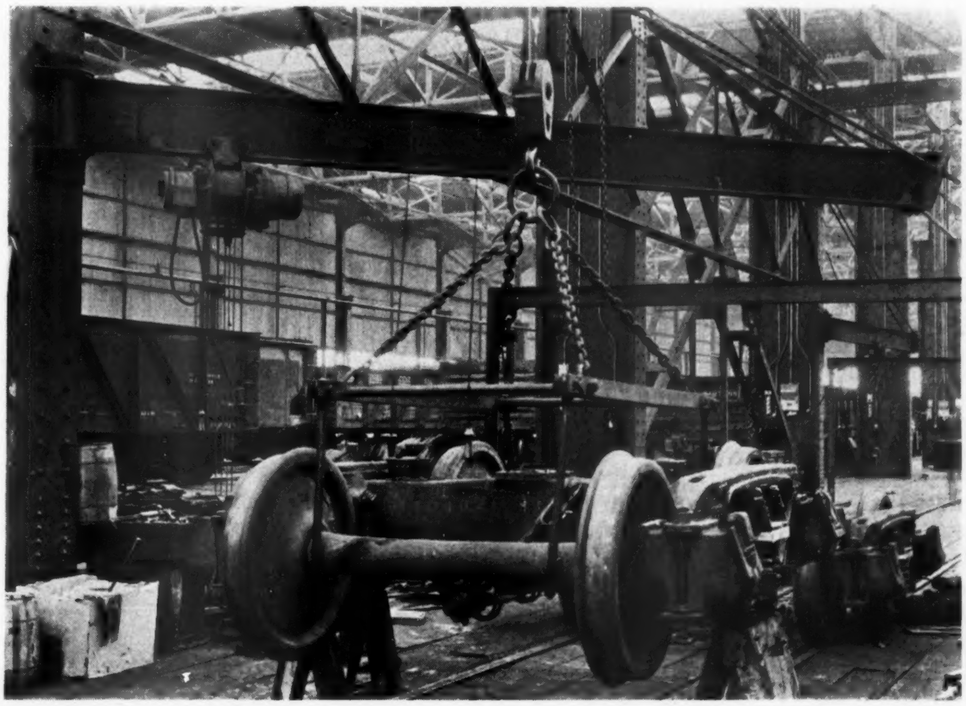


Fig. 7—Heavy jib crane, special crane hook and other devices used in the main truck assembly line

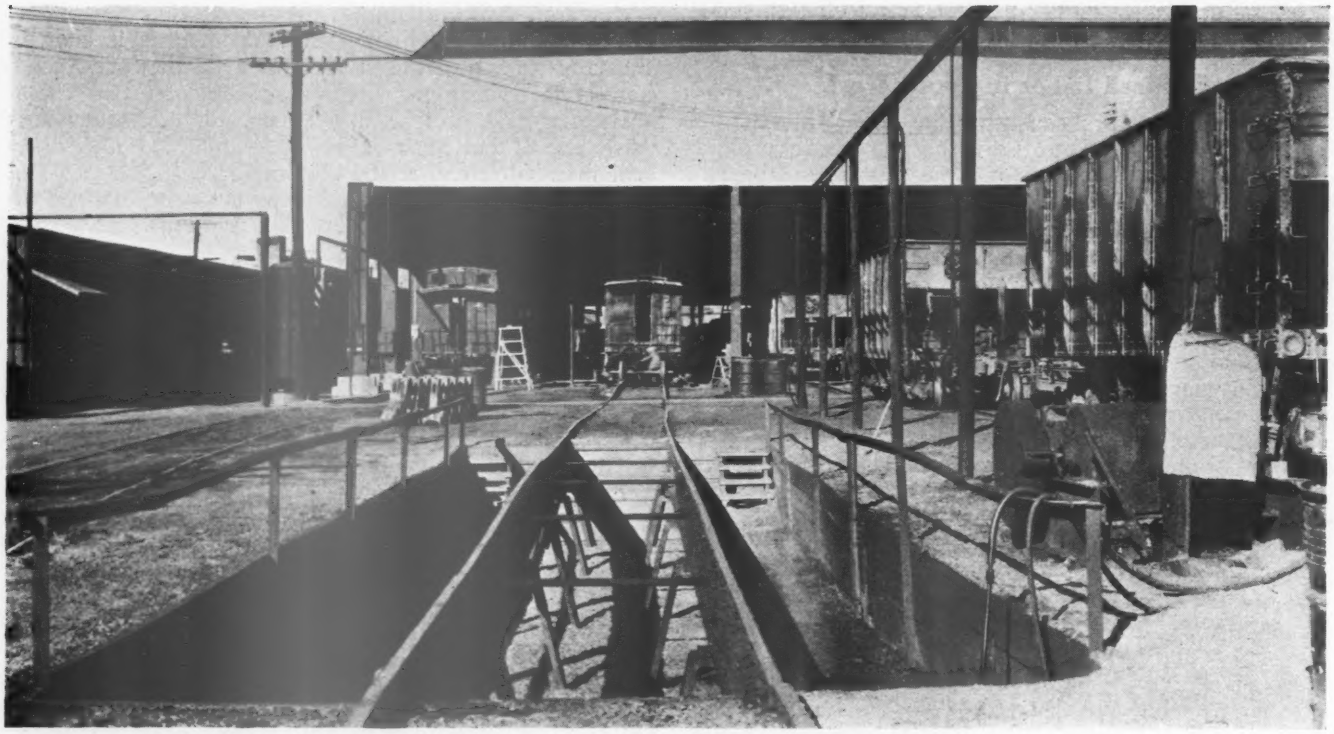


Fig. 8—One of two large pits used in spraying the under parts of cars with car cement

thorough painting job. Approximately 45 minutes per car is required for painting the complete underside, including the slope sheets of hopper cars. By former methods, a less satisfactory job was done in approximately twice the time.

The car cement used in this operation is received at the shop in 55-gal. metal drums and, to avoid loss of cement in draining the drums, especially in cold weather, the steam-heated device, shown at the right in Fig. 9, is used. This consists simply of a sheet-metal cylinder, mounted in an inclined position on a 1¼-in. angle iron framework, the cylinder being 44 in. long by 29 in. in outside diameter which is about 4 in. larger than the cement drum which is centered in it and held in place by a metal hook. Steam is piped to the cylinder and controlled by a small globe valve. When the galvanized-iron hood, illustrated in a raised position, is lowered and steam admitted to the cylinder for about 30 min., the drum is heated sufficiently so that the cement runs out by gravity and is caught in a paint pail underneath, leaving a practically clean drum. From ½ to 1 gal. of cement per drum is thus saved, dependent upon the outside temperature.

Other parts of the cars above the underframe are also painted at this position as shown in Fig. 9. The cars after sandblasting are given a protection coat of rust preventive before being received at the painting position. One of the vertical tanks, shown adjacent to the hopper car, is an air reservoir with provision for heating the air by means of a steam coil before it goes into the larger tank which also is heated and contains quick-drying mineral black paint used as the final coat on hopper cars. The paint is thus kept in a fluid condition and satisfactory for the quick and satisfactory spray painting of the car bodies, regardless of outside temperatures.

Car-Brass Trimmer

Referring to Fig. 10, a car-brass trimmer, furnished by the Journal Box Servicing Corporation, Indianapolis, Ind., is shown. This machine consists of a small double-head hand-operated shaper with special chuck for holding the brass and having cutter heads and tools with cross and vertical hand feed as shown. The machine itself is mounted on a steel frame which is carried on two 26-in. wheels with handles on the front for convenient movement about the shop and a box on the rear which contains brasses of different size. The particular model of car-brass trimmer illustrated has a hand-operated worm gear and quadrant which permits lowering and retracting the heavy part of the machine, moving the center of gravity closer to the wheels and thus permitting easier movement of the device about the shop.

All second-hand car brasses are trimmed in this machine; babbitt runs on the sides of the brass are removed and uniform lubrication thus assured throughout the

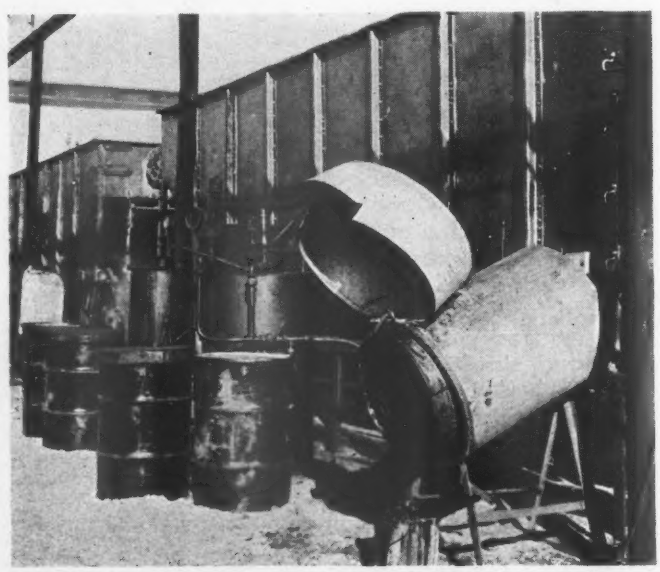


Fig. 9—Paint spray equipment and steam-heated device (at the right) used in warming drums to facilitate draining out all excess car cement

bearing. The brass is returned to the journal from which it was removed, the fit, therefore, being more accurate than with a new brass, with much less chance of a hot box developing. By this method of reclamation many car brasses are returned to service and improved performance secured.

The use of trimmed car brass is said to prevent trouble from three causes: Flow of hot oil away from the journal and bearing at the edge of the bearing; flow of oil out on the axle and wheel at the rear of the journal box; build up of lint from the oil under the babbitt overrun, shutting off the flow of oil to the journal. Such bearings, while operating at excessive temperatures and causing many failures, are not worn out, but, in fact, only properly seated and would run many years, perhaps, except for the over-run condition.

The Association of American Railroads' rules provide for the replacement of over-run bearings and tests indicate that 74 per cent of the bearings replaced are due to this cause. The same tests are said to have shown that 43.2 per cent of all bearings are in a partially over-run position, but not enough to justify replacement. The car-brass trimmer, in trimming the edges of linings and reshaping the original oil grooves where there are any,

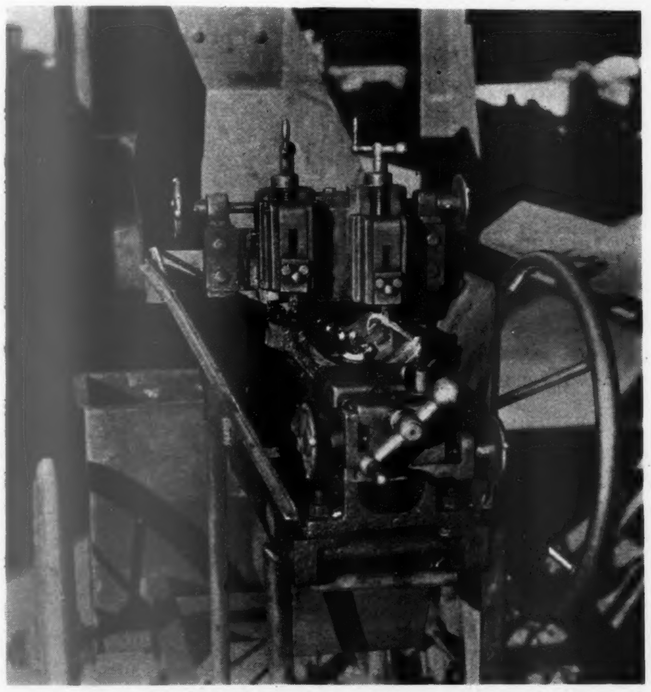


Fig. 10—Journal-brass trimmer which effects large economies by removing babbitt runs so that many brasses may be reclaimed for further service

puts brasses in condition to operate at 100 deg. F. lower temperature and saves 74 per cent of normal replacements.

The last illustration, Fig. 11, pictures a relatively simple device used at Centralia to assure the provision of cool drinking water to car men on the repair track with a minimum expenditure for ice. It consists simply of a small metal drum sunk vertically in the ground and containing at the bottom a few coils of the water supply pipe before it is connected to the drinking fountain in the upper part of the picure. The upper end of this drum has a double edge or annular ring, which is filled with water and becomes a water seal when the cover, shown in the illustration, is applied in a horizontal position. This drum is packed with ice early in the morning

Fig. 11—Efficient device for cooling drinking water—A great boon to car men on a hot day

and even on the hottest day does not require replenishment, owing to the fact that the drum is sunk in the ground where it is not exposed to hot surface air and the cover makes a water seal which is absolutely air tight. At least one icing a day is saved by means of this device.

Air Brake Questions and Answers

D-22-A Passenger Control Valve (Continued)

510—*Q.—How is this proportion rated?* A.—It is such that on cars having the brake rigging designed for 250 per cent braking ratio with 100 lb. brake cylinder pressure, this pressure is limited by the A-4-A valve to a maximum of 60 lb., or 150 per cent braking ratio, with 100 lb. displacement reservoir pressure.

511—*Q.—How is the release spring designed?* A.—So as to produce a sufficient force to overcome resistance of the diaphragm portion in order to insure release with low brake cylinder pressure.

512—*Q.—Is this release force effective at all times?* A.—No, only with application pressure of low value.

513—*Q.—Why is it undesirable to have this spring force at all times effective?* A.—It would prevent the desired close build up of the brake cylinder pressure with application pressure in chamber *A*.

514—*Q.—What functions to balance the release spring force and diaphragm resistance when application pressure in chamber A exceeds the low pressure for which it is adjusted?* A.—Levers known as 86 and 87, diaphragm *82* and spring *93* at the right of the diaphragm assembly balance the force of the release spring and diaphragm resistance.

515—*Q.—Explain the operation with less than 5 lb.*

application pressure in chamber A. A.—The balancing diaphragm is in normal position and the lower end of diaphragm level *87* is at its extreme left-hand movement. The middle connection of this lever is fulcrumed and the upper end, which is attached to the upper end of the large balance lever *86,* is at its extreme right-hand movement. This carries the upper end of the balancing lever to the right and, as the lower end of the lever fulcrums on the balance spring *93,* the middle connection does not offer resistance to the diaphragm follower, except when the diaphragm has moved far enough to the right to insure the release valve of the self-lapping unit being open.

516—*Q.—What does this provide for?* A.—The release bias of the release spring *53* is effective in affording positive release when application pressure in chamber *A* is reduced to a low value.

517—*Q.—Describe the operation when five to seven pounds application pressure is built up in chamber A.* A.—In this case the balancing diaphragm *82* is deflected to the right. This carries the lower end of the diaphragm lever to the right, and as it fulcrums on the middle lever connection, the upper end moves to the left carrying with it the upper end of the large balancing lever. This brings the middle connection of the large lever *86* into contact with the diaphragm follower on which the lever now fulcrums, and moves the lower end of the lever to the right, picking up the force of the balancing spring. The upper connection of the large lever now becomes the fulcrum and the force of the balancing spring is transmitted through the large lever to the diaphragm follower.

518—*Q.—Is a close relation between application pressure in chamber A and that developed in the brake cylinder required?* A.—Yes.

519—*Q.—What provides for this?* A.—The force delivered by the balancing spring to the diaphragm follower is sufficient to offset the release spring bias and insure the relativity required.

520—*Q.—How can the relay valve be converted for high-speed governor control so that the diaphragms produce the proper ratio of brake cylinder pressure for a given pressure in chamber A at predetermined speeds?* A.—By removing the follower between the two diaphragms, installing two additional diaphragms with followers, and substituting a magnet bracket for the blanking flange at the top face.

521—*Q.—What does the number, size, and location of brake cylinders depend on?* A.—The weight of the car and the particular installation.

522—*Q.—How is the UA type of brake cylinder designed?* A.—To prevent the entrance of dirt and the construction is such that lubrication of moving parts without removal of the piston or opening of the cylinder is possible.

523—*Q.—How are the cylinder body and pressure constructed?* A.—They are combined into a single casting which is provided with a bolting flange for mounting and a reinforced flanged union for the pipe connection.

524—*Q.—How is the piston constructed?* A.—The piston has a hollow rod which provides for a loose push rod. This rod is attached to the levers and rods of the foundation brake rigging. A push-rod holder is attached to the outer end of the piston rod.

525—*Q.—What type of packing cup is used?* A.—A solid packing cup.

526—*Q.—How is it held in place?* A.—The perimeter of the piston head is machined to form a shoulder over which the packing cup is fitted. The cup is applied by snapping it over the shoulder.

527—*Q.—What is back of the shoulder and what does it contain?* A.—There is a groove back of this shoulder which contains a cup supporting ring and a lubricator assembly with a felt packing ring or swab. The space back of the heel of the packing cup and in front of the felt swab provides a groove around the piston which, when filled with lubricant, serves to spread the lubricant over the cylinder wall with each movement of the piston.

528—*Q.—What is the purpose of the felt swab?* A.—It serves a double purpose; prevents overflow from the groove to the non-pressure side of the piston when the lubricant is introduced, and as the swab becomes saturated with the lubricant, results in the cylinder surface being lubricated with each application and release movement of the piston.

529—*Q.—When should the piston be lubricated?* A.—When in release position.

530—*Q.—Why is this?* A.—With the piston in release position, the grease cavity aligns with four grease ports in the cylinder body which are normally plugged.

531—*Q.—How is the lubricant applied?* A.—From the outside by means of a grease gun at any one of the four connections.

532—*Q.—What provision is made to prevent the entrance of dirt?* A.—The piston rod is ground true as to diameter and surface, and the non-pressure head is fitted with a piston rod lubricator and protector.

533—*Q.—What does the protector consist of?* A.—A felt swab and three bronze rings which are packed in grease, serving to lubricate the piston rod as well as to seal the interior of the cylinder against dirt and moisture.

534—*Q.—How are the piston rod and rings lubricated?* A.—A tapped opening in the non-pressure head provides a means of lubrication.

535—*Q.—What arrangement has been made to permit admission of atmospheric air to the non-pressure end of the cylinder during the release movement?* A.—The non-pressure head is fitted with a curled hair strainer of the cartridge type.

536—*Q.—How is the strainer held in place?* A.—By a breather cover which prevents dirt and water contacting the strainer.

537—*Q.—What is the function of the automatic slack adjuster?* A.—To maintain a predetermined brake cylinder piston travel.

538—*Q.—What does the type depend on?* A.—Brake cylinder location and mounting.

539—*Q.—How many general types are there?* A.—Three. Types A, B, and C.

540—*Q.—What is each type for?* A.—Type A is for mounting on the end of truck frame; Type B is for mounting on the end of brake cylinder when the cylinder is located on the car body, and Type C is for mounting on the top or side of the truck frame.

541—*Q.—Do all three types require slack adjuster lug and lever bracket on the cylinder pressure head?* A.—No, only the Type B.

542—*Q.—How do the various slack adjuster engines compare?* A.—The slack adjuster engine is the same general construction for all types, the variations being only in the body, to suit mounting requirements.

543—*Q.—What does the slack adjuster body contain?* A.—It contains a movable crosshead which serves as a fulcrum for the brake rigging cylinder lever. Movement is imparted to the crosshead through a screw, combined with a ratchet nut and pawl. The pawl is operated by a piston and spring.

544—*Q.—What controls the flow of air to and from the slack adjuster supply pipe which connects with the*

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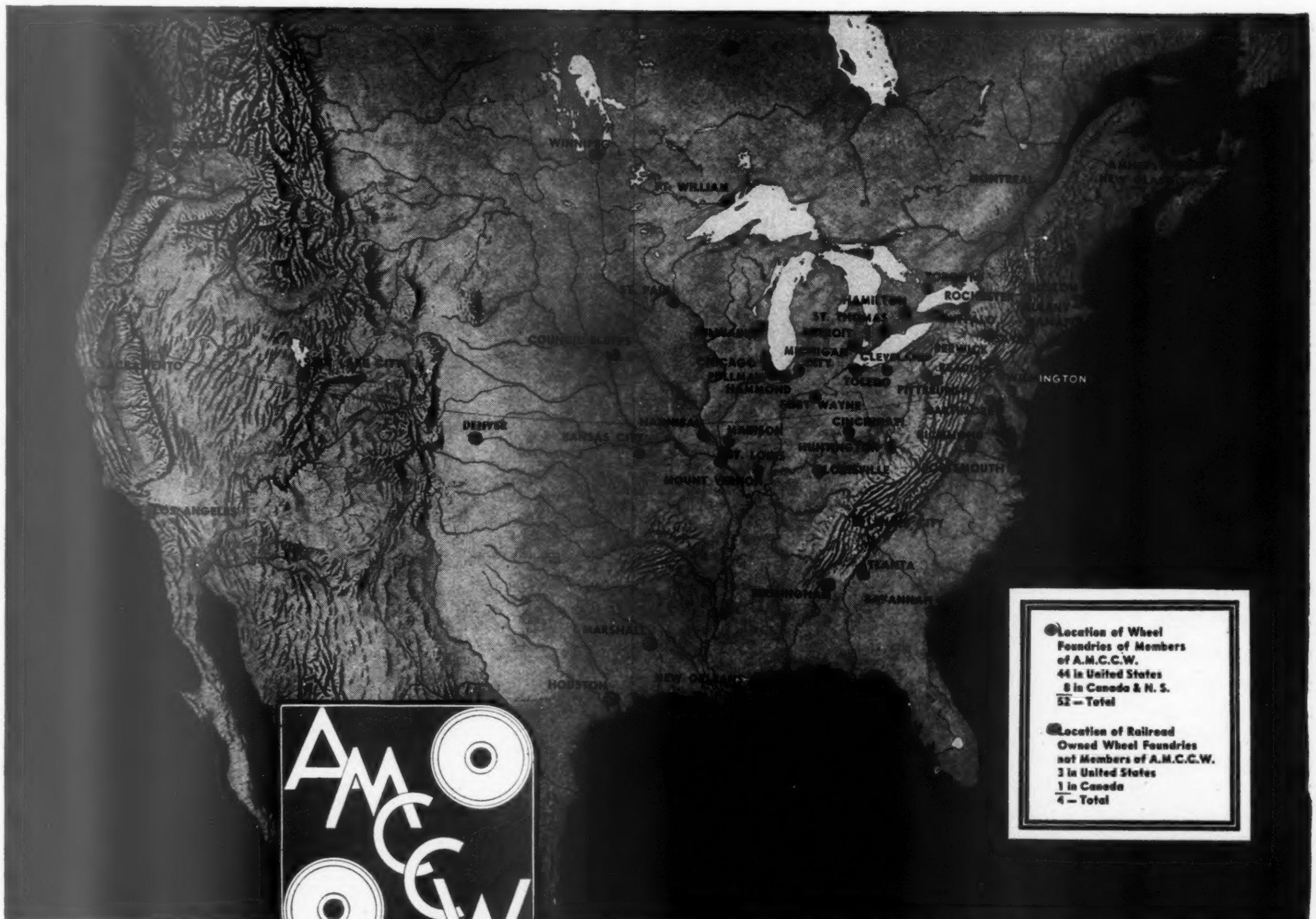

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cylinder? A.—The brake cylinder piston and packing cup act as a valve to function in this respect.

545—*Q.—What determines the point at which air is admitted to the slack adjuster?* A.—The port in the brake cylinder to which the slack adjuster supply pipe is connected is so located that the packing cup uncovers it when the predetermined piston travel is exceeded.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Claim of Poor Workmanship On New Axle Not Sustained

On January 17, 1937, the Southern applied one pair of new wheels, mounted on a new axle, to T. C. X. 3491 at its Jacksonville, Fla., shop. On September 3, 1937, the Seaboard Air Line removed the same pair of wheels and substituted a second-hand pair because of "journal not properly burnished and tool marks." The Pennsylvania-Conley Tank Line contended that the Southern was responsible for the condition of the journals as reported by the Seaboard because of poor workmanship and that the charge for wheels and axle applied should be reduced to second-hand.

The Southern stated that this car made several trips after receiving the new pair of wheels and finally was delivered empty by the Seaboard to the Southern on September 2, 1937. It was returned to the Seaboard on the same day because the L-3 journal was cut. The Southern noted that the repair card of the Seaboard made no reference to the cut journal but had a notation of "the R-3 journal not properly burnished and tool marks". This road explained to the Pennsylvania-Conley that this was a case of delivering-line defect and that it should handle the matter with the Seaboard Air Line for cancellation of the bill. The Southern contended that it had no responsibility whatever in this case.

In a decision rendered April 14, 1939, the Arbitration Committee stated: "The evidence submitted indicates the axle required conditioning due to heating which, under Rule 84, is a delivery company responsibility. The contention of the Southern is sustained."—*Case No. 1770, Southern versus Pennsylvania-Conley Tank Line.*

Responsibility for Damages Due to Bad Track and Weather

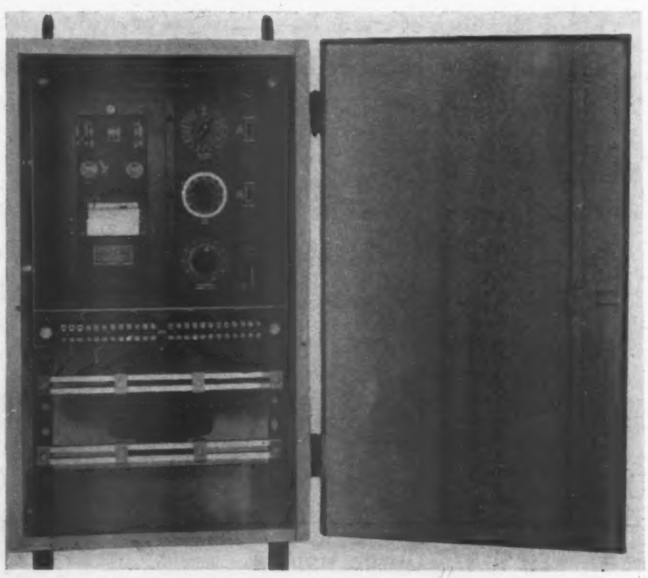
On February 16, 1938, a Missouri Pacific train stalled on a hill making it necessary to double the train over the hill. Texas & New Orleans car No. 39152 was the first car on the rear portion of the train and in making the coupling this car was damaged. The M. P. stated that there were no derailments of cars in this accident, no misinterpreted signals involved, nor any failure to give or observe signals and at the time of the accident it was cold, sleety and the rails were covered with ice. The T. & N. O. contended the engine collided with the rear portion of the train, making the damage a handling-line responsibility under the classification of train collision, specified in paragraph (c), Rule 32. The M. P. claimed there was no violation of Rule 32 as there were no cars derailed and that the locomotive in coupling on was moving on a down grade between six and eight miles per hour, and this speed could not be considered excessive in view of the weather and track conditions. It contended that since there was no element of negligence involved on the part of the M. P. to comply with every measure of safety in the handling of this car, and believed the responsibility for the damage should be charged to the car owner.

In a decision rendered April 14, 1939, the Arbitration Committee stated: "The circumstances under which this damage occurred as disclosed by the investigation of the M. P. clearly indicates the handling line responsibility under Item C, Section 10, Rule 32. The contention of the car owner is sustained."—*Case No. 1771, Missouri Pacific versus Texas & New Orleans.*

Weld Recorder Indicates Defective Welds

The increased use of welding and more rigid specifications have made sound, dependable welds a primary requirement. Spot welding is now being used extensively on structural members of railroad cars which are subjected to vibrational stresses of considerable magnitude. Because the numerous variables affecting the quality of spot welds are not under constant control, the General Electric Company, Schenectady, N. Y., has developed a weld recorder to record and indicate these variations. The weld recorder acts as a recording instrument, signalling device, and lockout control which measures the electrical input to the spot-welding machine for each spot weld.

The weld recorder is so designed that when the electrical input to the welder varies sufficiently to cause a defective weld, a bell gives a continuous audible signal, and the weld-initiating circuit is automatically opened, preventing subsequent welding until a push button is pressed. In addition, the recorder chart indicates visually that the weld was not within the pre-set allowable limits for proper welding and shows whether the heat was above or below normal.



A General Electric Company's weld recorder

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TWELVE new 2-8-8-4 high-speed Mallets have recently been delivered by Lima to the Southern Pacific. These locomotives are outstanding examples of the type that is being ordered by the progressive railroads to meet the present-day demands of heavier loads moved at higher speeds.
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Mile-A-Minute Train Speeds

In 1928, except for one or two short runs in New Jersey, there was not a single train in the United States scheduled from start to stop at an average of more than 60 miles an hour. The Railroad Magazine has made a practice of compiling annual records of high train speeds and this year a summary of its article is being circulated by the A.A.R. According to this compilation, the passenger schedules of American railroads now show a daily mileage of 54,956 run at 60 miles per hour, or an increase of 16.7 per cent over the mile-a-minute mileage of a year ago.

Hard on Boilermakers

Water for locomotive use on the Western lines of the Illinois Central is highly mineralized and quite unsuitable for use in locomotive boilers. In 1915, and for several years prior thereto, there was a failure for every 5,000 locomotive-miles. Water treating methods were introduced and eventually improved to the point where since 1932 only softened water has been delivered to locomotives running west of Chicago. As a result, according to an article in the Railway Age, engine failures have been reduced to the point where, instead of one failure for every 5,000 locomotive miles, the ratio is now one engine failure to 10,000,000 locomotive-miles. Prior to 1929 it was necessary to rebuild fireboxes at intervals of 11 to 18 months. Contrasted with this, no firebox has been renewed on locomotives assigned to Western lines in more than 10 years, while on the system as a whole, only 10 fireboxes have been renewed during the last five years on the 1,523 locomotives in active service. Instead of the 75 boilermakers formerly employed at Waterloo, only 12 are now required, and one day and one night boilermaker are sufficient at the local enginehouses.

Wrecks in the Reich

It is difficult to know just what to believe about reports coming from countries engaged in war. There seems to be no question, however, about the fact that there have been ten serious railroad disasters on the German railways since the beginning of the European war four months ago. Well over 300 persons have been killed and as many injured. There is a good bit of guessing as to the underlying reasons for this. It has been suggested that undermaintenance has been steadily increasing over the long period during which the Nazis have been preparing for war. There is also a question as to the personnel and its morale. It hardly seems likely that the trained personnel would have been interfered with, since the strategic importance of the railways is so great in a conflict where large forces may have to be shifted quickly from one front to another. Confusion, however, may have been caused by the re-assignment of the forces to meet some of these conditions. Or the organization may have become exhausted or demoralized by the heavy demands which have been made upon it. The suggestion has also been made that the Fuehrer has concentrated too much attention on the marvelous system of motor highways, possibly to the detriment of the railways. If such serious difficulties are already being encountered, what will happen when the transportation system must be further speeded up, as the war progresses and more activity is shown on the western front?

Pipe Lines Lucrative

Harold Ickes, when he was administrator of the Code of Fair Competition for the petroleum industry, thought that the pipe line carriers were not charging enough for their services, or at least he urged the suspension of reduced rate tariffs filed by 37 carriers of crude oil by pipe line. The Interstate Commerce Commission assigned the job of checking up on these rates to its examiner, J. Paul Kelley, and his proposed report has just been made public. The oil companies maintain and control these pipe lines for their own use. Apparently these subsidiaries were making too much money, at least from the standpoint of federal income and other taxes. The proposed report reviewed returns to questionnaires which showed that "practically all of the respondents have in the period 1929-38 returned in dividends to their owners all of the moneys invested in the pipe lines." Since the pipe lines of these companies are not used by the public, except insofar as the oil companies for whose benefit the lines are operated constitute a part of the public, the examiner questions the advisability of suspending the reduced rate tariffs.

British Suburban Trains Allowed More White Light

The British public has not been any too well pleased with the blackout and the necessity of using blue lights on trains. It is impossible to read with such lights and this condition has proved irksome even in the short run suburban services. During the latter part of December several experiments were made on a fairly large scale with the limited use of white light. In general, the blue lights are kept on at all times. Between stations hooded white lights are also used, the curtains being carefully drawn down over the windows. The white lights are shut off when the trains approach stations and during the stop, in order that no rays of light may escape through the open doors as the passengers enter or leave the cars. The Southern Railway distributed leaflets to the passengers, explaining in great detail exactly what procedure should be followed. The statement closed with these words: "In this country the public have the reputation of playing the game and the Southern feels they will help in all ways possible to enable the government to give permanent permission to continue this form of lighting, and so assure comfort with safety for the passenger." It also pointed out that if the members of the traveling public play their part, not only will they be able to read their papers going home in the evening, but they will also assist in insuring that the trains will spend less time at stations and that they themselves will reach their homes earlier.

Canada's Railways on the Job

S. W. Fairweather, chief of research and development of the Canadian National Railways, pointed out recently in an address at Vancouver, B. C., that "It may well be that the decisive factor in favor of the Allies will be their superior lines of communication of sources of food, munitions and supplies." He also indicated that the railways of Canada form an important, if not a vital, link in the lines of communication of the Allies, and made some comparisons to show that they were much better equipped to meet the present situation than they were during the World War in 1914. At that time they were equipped with 80 and 90-lb. steel rails, whereas today the main line standard is from 100 to 130-lb. The largest road freight locomotive in 1914 had a tractive effort of 52,000 lb. This has increased until today it is over 90,000 lb. The average freight train of 1914 hauled 350 tons of freight, while the one of today hauls 550 tons. The average freight train speed has increased from 10 to 17 miles an hour. Today only 120 lb. of coal are burned to haul 1,000 tons a mile, as compared to 160 lb. in 1914. The average capacity of the freight car has increased from 33 tons to 42 tons. "The significance of those figures," said Mr. Fairweather, "is that for the same expenditures of labor and materials we manage to get 50 per cent more transportation today than we did in 1914."

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The Diesel-powered "Henry M. Flagler" of the Florida East Coast operates between Jacksonville, Fla., and Miami

NEWS

Stock Locomotives To Be Built by Baldwin

An initial investment of more than $2,000,000 is being made by The Baldwin Locomotive Works for facilities and stock to build 28 Diesel-electric switching locomotives of 1,000 and 660 hp. in line production so that certain types of railroad motive power can in future be chosen from stock. Two of the locomotives were recently demonstrated at its Eddystone, Pa., plant. The schedule calls for completion of the 28 engines for switching and transfer service, whether or not orders for them are received beforehand. The completion of smaller type locomotives for stock purposes is a new policy for Baldwin. The two engines displayed are powered by De La Vergne Diesels, manufactured by a Baldwin subsidiary; both are designed to provide good visibility, as a safety feature for yard service, and easy mechanical accessibility. The 1,000-hp. locomotive weighs 124 tons, while the weight of the 660-hp. locomotive is about 100 tons.

Fusion-Welded Tank Cars

The General American Transportation Corporation has been authorized by the Interstate Commerce Commission to construct 50 additional fusion-welded tank cars for experimental service in the transportation of petroleum products.

The American Car and Foundry Co. has been authorized by the Interstate Commerce Commission to construct five additional fusion-welded tank cars for experimental service in the transportation of petroleum products, and to construct four tank cars with riveted aluminum alloy tanks for experimental service in the transportation of 95 per cent nitric acid.

Lawford H. Fry Now Chairman A. S. M. E. Railroad Division

Following the annual meeting of the American Society of Mechanical Engineers held at the Bellevue-Stratford Hotel, Philadelphia, Pa., December 4-8, Lawford H. Fry, railway engineer, Edgewater Steel Company, succeeded to the chairmanship of the Railroad Division of the society. C. T. Ripley, chief engineer, Technical Board, Wrought Steel Wheel Industry, the retiring chairman, becomes a member of the Standing Committee on Professional Divisions of the society.

Occupations of Unemployment Insurance Beneficiaries

Maintenance-of-equipment and maintenance-of-way employees constituted the majority of the claimants for whom one or more unemployment insurance payments had been certified by the Railroad Retirement Board by November 10.

As of that date there were 75,675 beneficiaries. The last occupation in which 71,923 of them were employed was readily identified from statements made on the claim form. Of this total 26,958, or 37.5 per cent, last worked in the maintenance-of-equipment department, and 17,517, or 24.4 per cent, in maintenance-of-way and structures. Train, engine and yard employees accounted for 17.8 per cent of the total and employees generally classified with the station forces constituted 13.9 per cent.

The figures apply to the country as a whole. The proportion of beneficiaries in different occupations, however, varied somewhat in the different regions.

Equipment Depreciation Orders

Equipment depreciation rates for six railroads, including the Southern Pacific and the Chicago Great Western, are prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15,100, Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates range from 2.48 per cent for the Lorain & Southern to 3.13 per cent for the C. G. W., exclusive of equipment leased from the General American Car Corporation.

The Southern Pacific's composite percentage of 3.05 is derived from a variety of prescribed rates as follows: Steam locomotives, 2.9 per cent; other locomotives, 5.74 per cent; freight-train cars, 3.22 per cent; "City of San Francisco" type passenger equipment, 6.4 per cent; "Daylight" type passenger equipment, 3.84 per cent; all other passenger equipment, 2.58 per cent; floating equipment of Southern Pacific Steamship Lines, 2.83 per cent; all other S. P. floating equipment, 3.63 per cent; work equipment of S. P. Steamship Lines, 3.05 per cent; all other work equip-

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ment, 3.38 per cent; miscellaneous equipment of S. P. Steamship Lines, 10.53 per cent; all other miscellaneous equipment, 9.34 per cent.

The above-mentioned composite percentage of 3.13 for the C. G. W. is derived from prescribed rates as follows: Steam locomotives—owned, 3.03 per cent, leased from the Mason City & Fort Dodge, 2.35 per cent, leased from the St. Paul Bridge & Terminal, 3.2 per cent; other locomotives—owned, 4 per cent; freight-train cars—owned, 3.02 per cent; leased from M. C. & F. D., 1.93 per cent, leased from St. P. B. & T., 3.21 per cent, leased from General American Car Corporation, 3.6 per cent; passenger-train-cars—owned, 3.33 per cent, leased from M. C. & F. D., 2.27 per cent; work equipment—owned, 4.37 per cent; leased from M. C. & F. D., 2.28 per cent, leased from St. P. B. & T., 2.29 per cent; miscellaneous equipment—owned, 19.81 per cent.

A. S. M. E. Honors Railroad Engineers

At the annual dinner and "honors night" of the American Society of Mechanical Engineers held during the annual meeting of the society at the Hotel Bellevue-Stratford, Philadelphia, Pa., December 4 to 8, honorary membership in the society was conferred on Henry Hague Vaughn. Mr. Vaughn is widely known for his influence on the design of cars and locomotives and the organization of the shops on the Canadian Pacific while assistant to vice-president in charge of the mechanical department during the nine years prior to 1915. Since leaving the railroad in 1915, Mr. Vaughn has been engaged in industry and as a consulting engineer in Canada.

Dr. Rupen Eksergian of the Edward G. Budd Manufacturing Company was the recipient of the Worcester Reed Warner Medal awarded for his contributions to permanent engineering literature. Dr. Eksergian has been a prolific writer on various phases of locomotive and car design and on applied mechanics subjects.

Equipment Purchasing and Modernization Programs

Chicago Great Western.—The federal district court at Chicago on December 6 authorized the Chicago Great Western to execute a lease with the Pullman Standard Car Manufacturing Company involving $200,000 for 100 flat cars, under the terms of which lease payments would apply toward eventual purchase of the cars. The placing of the order for these cars was announced in the November issue of the *Railway Mechanical Engineer.*

Chicago, Rock Island & Pacific.—The Rock Island has asked the Interstate Commerce Commission to approve a plan whereby it would issue and sell to the Reconstruction Finance Corporation $2,680,000 of 2¾ per cent equipment trust certificates, maturing in 20 equal semi-annual installments beginning August 1, 1940. The proceeds would be used in part payment for the purchase of 1,000 50-ton box cars and 10 Diesel-electric switching locomotives, costing a total of $2,993,420. The placing of the orders for this equipment was announced in the November and December issues, respectively.

The Rock Island has also undertaken a locomotive modernization program calling for the expenditure of about $600,000. Roller bearings are being applied to 55 locomotives, of which 40 are in freight service and 15 in passenger service. In addition to the installation of roller bearings, some of the passenger locomotives are being rebuilt.

Colorado & Southern-Fort Worth & Denver City.—These companies have asked the Interstate Commerce Commission to approve a plan whereby they would borrow from the Reconstruction Finance Corporation $1,300,000 to finance the purchase of two new Diesel-electric streamline Zephyr-type trains to be operated in daily overnight service over the Colorado & Southern and the Fort Worth & Denver City between Denver, Colo., and Dallas, Tex., on a schedule six hours faster than is now in effect. The two companies estimate that the installation of the new trains would increase passenger earnings and result in savings totaling $335,844 a year. They would issue and sell to the Reconstruction Finance Corporation three per cent equipment trust certificates to mature serially over a period of 10 years. In separate applications the C. & S. asked for a loan of $680,500, while the Fort Worth & Denver City requested $619,500. The application pointed out that the Diesel-electric locomotives can be purchased from the Electro-Motive Corporation for $376,000 each, while each train of four cars can be obtained from the E. G. Budd Manufacturing Company at a price of around $304,500.

Illinois Central.—Interstate Commerce Commission Finance Director O. E. Sweet has informed this company that Division 4 cannot approve the new $5,000,000 Reconstruction Finance Corporation loan for the equipment repairs mentioned in the November issue of the *Railway Mechanical Engineer,* on the ground that the collateral offered is insufficient to secure the advance. The Illinois Central refused to withdraw its application.

New York Central.—The New York Central has been authorized by Division 4 of the Interstate Commerce Commission to assume liability for $9,000,000 of 2½ per cent equipment trust certificates, maturing in 10 equal annual installments of $900,000 on December 1 in each of the years from 1940 to 1949, inclusive. At the same time Division 4 authorized sale of the certificates to the Reconstruction Finance Corporation at par and accrued interest with the stipulation that the company agree with the R. F. C. that it will spend within one year from October 1, 1939, not less than $3,600,000 in repairing and reconditioning its own equipment. This is the first time that an R. F. C. loan has contained the latter condition.

St. Louis-Southwestern.—A budget providing for the expenditure of $2,082,754 for additions and betterments on the St. Louis Southwestern in 1940, was approved by the federal district court on December 15. The amount includes $562,022 for freight cars to be built in company shops and $243,088 for rails ordered last October.

Tennessee Central.—The Tennessee Central has asked the Interstate Commerce Commission to approve a plan whereby it would issue and sell to the Reconstruction Finance Corporation $185,000 of 2¾ per cent equipment trust certificates, maturing in 20 semi-annual installments of $10,000 on July 1, 1940, and the same amount on January 1, and July 1, thereafter, to and including July 1, 1942, and in the amount of $9,000 on January 1, and July 1, in each of the years thereafter to and including

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Orders and Inquiries for New Equipment Placed Since the Closing of the December Issue

Locomotive Orders

Road	No. of Locos.	Type of Loco.	Builder
Canadian Pacific	5	4-6-4	Montreal Loco. Wks.
C. B. & Q.	10	4-8-4	Company shops
D. & H.	20	4-6-6-4	American Locomotive Co.
Panama Canal	5	2-6-0	American Locomotive Co.
Wheeling & Lake Erie	4	0-6-0	Company shops

Freight-Car Orders

Road	No. of Cars	Type of Car	Builder
Lake Terminal	100	70-ton gondola	American Car & Fdy. Co.
United Fruit Co.	77	25-ton flat	Magor Car Corp.

Freight-Car Inquiries

Road	No. of Cars	Type of Car	Builder
Norfolk & Western	100	50-ton box	....

Passenger-Car Orders

Road	No. of Cars	Type of Car	Builder
Pullman Company	13	Roomette-bedroom	Pullman-Std. Car Mfg. Co.
	6	Roomette	....
	11	Bedroom-compartment-drawing room	....
	8	Bedroom	....
	12*	Bedroom-buffet-lounge	....
	33	Roomette-bedroom	....
	4	Duplex single-bedroom	....
	13†	Bedroom-buffet-lounge	....
Richmond, Fredericksburg & Potomac	6	Bagg.-exp.	American Car & Fdy. Co.

* For use on the New York Central.
† For use on the Pennsylvania.

January 1, 1950. The proceeds would be used to purchase the 65 all-steel 50-ton hopper cars and one Diesel-electric switching locomotive, the placing of orders for which were announced in the November and December issues respectively.

Texas & Pacific—The Texas & Pacific has been authorized by Division 4 of the Interstate Commerce Commission to assume liability for $1,335,000 of three per cent equipment trust certificates, maturing in 15 equal annual installments of $89,000 on January 15 in each of the years from 1941 to 1955, inclusive. At the same time Division 4 approved the purchase by the Reconstruction Finance Corporation of the entire issue at a price not in excess of par and accrued interest.

Commissioner Porter dissented, saying that "The cash payment is to be less than 0.7 per cent of the applicant's outlay for the equipment. Several times I have indicated my unwillingness to approve borrowing on new equipment of more than 90 per cent of the net cost thereof. Especially would such a policy incur no hardship here, for the applicant anticipates a cash balance by the end of the year of over $2,300,000 and is well able to pay at least 10 per cent if not 20 per cent in cash at the time of the purchase."

Wabash—Division 4 of the Interstate Commerce Commission has approved a loan to the Wabash by the Reconstruction Finance Corporation in the amount of $9,300,000, of which $6,500,000 is to be applied to the retirement of a like amount of equipment notes issued by the company to the R. F. C., and $2,800,000 to be applied to the cost of repairing and rehabilitating 1,694 automobile box cars. The loan will be evidenced by 2½ per cent equipment trust certificates, maturing in installments of at least $620,000 semiannually on July 1 and January 1 of each year until the full amount has been repaid, the first installment to be due and payable on July 1, 1940, and the last installment to be due and payable on July 1, 1947, with the further provision that the company may make additional payments of not less than $25,000 on account of unmatured installments of principal.

Charles F. Carter Dies at 76

CHARLES Frederick Carter, believed to be one of the country's most prolific writers of railroad stories and articles, died on December 10 at his home in New York at the age of 76.

Mr. Carter's interest in railroading began in 1881 when he obtained his first railroad job as an engine wiper on the Chicago, St. Paul, Minneapolis & Omaha. In 1889, he entered journalism as a reporter and later filled more advanced editorial positions on various papers in Denver, Colo., New York and Brooklyn. In 1906, Mr. Carter joined the staff of "Railroadman's Magazine." From 1923 to 1932 he was special representative in the New York Central's department of public relations.

He was author of "When Railroads Were New," published originally in 1909, and in a revised centenary edition in 1926; "Big Railroading," published in 1919, and numerous magazine and encyclopedia articles on industrial and economic subjects.

Outlook "More Encouraging" Says Pelley

WHILE he found the outlook for the railroads "more encouraging" as the year 1939 drew to a close, J. J. Pelley, president of the Association of American Railroads, nevertheless asserted in his year-end statement that the improvement in traffic and earnings "does not obviate the need for a national transportation policy placing all agencies of transportation on a equal footing under the law." He went on to express the hope that the differences between the Senate and House versions of S. 2009, the omnibus transportation bill, "will be ironed out early in the coming session of Congress and the resulting bill speedily enacted into law."

From preliminary reports Mr. Pelley estimated that the 1939 net railway operating income will be $600,000,000, a return of 2⅛ per cent, while the net income after fixed charges will be $95,000,000, as compared respectively with a net railway operating income of $372,874,000 or 1.43 per cent and a net deficit after fixed charges of $123,471,074 in 1938.

Mr. Pelley said that the railroads will enter 1940 with a freight traffic level approximately 10 per cent higher than a year ago and about 18 per cent above two years ago. Despite the record-breaking climb in traffic during the fall, he said that the railroads have met the transportation situation successfully with virtually no car shortage except for a few isolated cases where slight delays occurred in furnishing certain special types of cars. The speeding up of equipment maintenance and the increase in freight movement, he said, had increased employment on the railroads until in October there were 1,005,164 employees. more than in any month since November, 1937, and nearly 80,000 more than in October, 1938. Of the total number, 511,358 were engaged in maintenance work, an increase of 53,612 over October, 1938.

In the matter of expenditures, Mr. Pelley cited the fact that the purchases of fuel, supplies and materials used in current operation in 1939 amounted to $750,000,000 for the Class I railroads, compared with $583,282,000 in 1938 and $966,383,000 in 1937. The capital expenditures for equipment, roadway and structures and other improvements in property for 1939, he said, were estimated at $375,000,000, compared with $226,937,000 a year ago. This he contrasted with $794,000,000 average annual capital expenditures from 1927 to 1930.

Supply Trade Notes

THOMAS E. SCULLY has been appointed representative of the Chicago Railway Equipment Company, Chicago.

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R. J. VAN METER, assistant to the vice-president of the Superheater Company, Chicago, has been promoted to manager of western sales and service.

◆

FRANK T. KALAS, general sales manager of The Electric Storage Battery Company, Philadelphia, Pa., has been elected third vice-president.

◆

JOHN A. DILLON, vice-president in charge of eastern sales of the Pittsburgh Screw and Bolt Corporation, New York, resigned on January 1. He was associated with this company for more than 20 years. Mr. Dillon started in the steel business in connection with the National Tube Company at Pittsburgh, Pa., and was later transferred to their New York office where he was employed for 13 years before entering the service of the bolt and nut trade.

ARTHUR E. LEGARE, sales engineer of the General Steel Castings Corporation at Granite City, Ill., has been transferred to Chicago, from which he will handle the same territory as heretofore.

◆

DR. WILLIAM A. MUDGE has joined the technical service division of the New York office of The International Nickel Company, Inc. For the past 17 years, Dr. Mudge has been superintendent of research, superintendent of the refinery and works metallurgist at the company's Huntington, W. Va., rolling mill and for two years previous was at the company's Bayonne, N. J., refinery, where he joined International Nickel in 1920.

◆

JAMES ISAACS has been appointed assistant to president of The Pilliod Company, with headquarters at 30 Church street, New York City. Mr. Isaacs, who has been associated with the railway supply industry since 1920, will continue to represent manufacturers as in the past.

THE MILLER-LEWIS RAILROAD EQUIPMENT CORPORATION, 80 Reade street, New York, has been appointed eastern representative of the Standard Car Truck Company, Chicago, and its division, Standard Car Sales, Inc., a recently-formed corporation.

◆

H. B. GAY, third vice-president and general sales manager, also a member of the board of directors of The Electric Storage Battery Company, retired from active service on December 1 after thirty-eight years in the employ of the company.

◆

MAYNARD D. CHURCH has been elected a vice-president of the Worthington Pump & Machinery Corp., Harrison, N. J. Mr. Church is also president of the Moore Steam Turbine Corporation, Wellsville, N. Y., a Worthington subsidiary, and will continue in charge of the Moore operations. R. W. Towne, secretary and assistant treasurer since 1936 of the Moore organi-

zation, has been elected assistant secretary of the Worthington Pump & Machinery Corp.

◆

JAMES E. DAVENPORT has been appointed assistant to vice-president-engineering, American Locomotive Company, with office at New York and with such duties as may be assigned to him. Mr. Davenport was born at Charlestown, W. Va., on October 8, 1887. He was graduated from the Georgia School of Technology with a B. S. in M. E., in 1908, and a B. S. in E. E. in 1909. Mr. Davenport entered railway

James E. Davenport

service in 1909 as a special apprentice at the West Albany, N. Y., shops of the New York Central and his entire career has been with that road. From 1912 to 1914, he was enginehouse foreman at North White Plains, N. Y., then to 1917, dynamometer car engineer. During 1917 and 1918 he was trainmaster on the Harlem division and then to 1920, trainmaster on the Mohawk division. From 1920 to 1923 he was engineer, dynamometer tests, and then to 1926, superintendent, fuel and locomotive performance. He served in 1926 and 1927 as superintendent of the Adirondack division, then for the next three years as superintendent of the River division. In 1930 he was appointed assistant to assistant general manager, and in 1931 became assistant to executive vice-president. From 1936 until his resignation to become associated with the American Locomotive Company, Mr. Davenport had been assistant chief engineer of motive power and rolling stock. During 1927-1928 he was president of the International Railway Fuel Association.

◆

THE VANADIUM CORPORATION OF AMERICA has moved its Pittsburgh, Pa., district sales office from its Bridgeville, Pa., plant to the Henry W. Oliver building, Pittsburgh. G. F. Fritschi is the Pittsburgh district manager of sales.

◆

HERBERT J. WATT has been appointed manager of sales for the central area of the Carnegie-Illinois Steel Corporation. Mr. Watt will co-ordinate sales activities of Carnegie-Illinois offices at Pittsburgh, Pa., Cleveland, Ohio, Cincinnati, and Detroit, Mich. His headquarters will be at the general offices in the Carnegie building, Pittsburgh. Mr. Watt entered the steel industry in the Philadelphia office of Carnegie Steel Company in 1912 and in 1917 was transferred to the Washington office of United States Steel Corporation Subsidiaries. He was formerly assistant general manager of sales for the Jones & Laughlin Steel Corporation.

◆

J. B. PEDDLE, Paul Brown building, St. Louis, Mo., has been appointed St. Louis district sales representative for the McConway & Torley Corporation, Pittsburgh, Pa.

◆

HARRY GLAENZER, vice-president in charge of engineering of The Baldwin Locomotive Works has retired because of ill health. Mr. Glaenzer was educated in the technical schools of Baltimore, Md., and in the University of Pennsylvania. His work in the engineering department of Baldwin began in March, 1899, and covered all phases of locomotive design. During the years 1918-1919, while the railroads of the country were being operated by the United States Railroad Administra-

H. Glaenzer

tion, Mr. Glaenzer was actively associated with the committees that prepared designs for a series of standard locomotives. He was appointed assistant chief engineer of The Baldwin Locomotive Works in 1919, chief engineer in 1921, and vice-president in charge of engineering on July 1, 1922. In 1924 he made a trip to Japan, where he studied the equipment and operation of the Japanese Railways. On April 8, 1939, he assumed new and enlarged responsibilities in connection with the engineering activities of Baldwin, devoting all his time to research and investigation. Mr. Glaenzer has patented various devices applicable to locomotives and was chairman of the builders' committee which collaborated with the Pennsylvania in the design of the Class S-1 locomotive exhibited at the New York World's Fair in 1939. He also served on the A.A.R. Committee for the Further Development of the Reciprocating Steam Locomotive.

◆

LOUIS H. BRENDEL, assistant sales manager of the Hancock Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., has been promoted to assist C. H. Butterfield, general sales manager of the company.

STANDARD CAR SALES, INC., Chicago, has been organized to act as manufacturers' representatives for car devices. At the present time, the company is selling the Champion handbrake manufactured by the Champion Handbrake Corporation, Chicago, and the Walton air filter manufactured by the Research Products Corporation, Madison, Wis. The officers of the new company are F. L. Barber, chairman of the board; R. E. Frame, president; F. D. Barber, vice-president; John W. Miller, vice-president; V. Fraser, secretary, and John E. Edgerton, treasurer.

◆

THE ARDCO MANUFACTURING COMPANY has moved its office from 1 Newark street, Hoboken, N. J., to 137-143 Franklin street, Jersey City, N. J. At the new address they will combine their office with their manufacturing facilities which include locomotive drifting valves, cylinder cocks and rail lubricators.

◆

WILLIAM M. SHEEHAN, manager of Eastern district sales for the General Steel Castings Corporation, Eddystone, Pa., has been appointed assistant vice-president-sales, and James Macdonald, sales representative, has been promoted to assistant to the vice-president-sales. Mr. Sheehan was born in Virginia and was educated in St. Andrew's school, Roanoke, Va., and St. Louis university. His early railroad experience was secured on the Norfolk & Western and the Erie. Later he served for a time in the engineering departments of the General Electric Company, the American Locomotive Company, the New York Air Brake Company, and the Keith Car & Mfg. Co. Since 1913 he has been

W. M. Sheehan

associated with the Commonwealth Steel Company and its successor, the General Steel Castings Corporation, as assistant mechanical engineer, sales engineer, and, since July 1, 1931, as manager, Eastern district sales. Mr. Macdonald was associated with the Baldwin Locomotive Works in various capacities from 1931 until January, 1939, when he joined the sales force of the General Steel Castings Corporation.

◆

WALTER CHADWICK, executive vice-president of the Davenport Besler Corporation, Davenport, Iowa, has been elected president, to succeed Charles Pasche, deceased.

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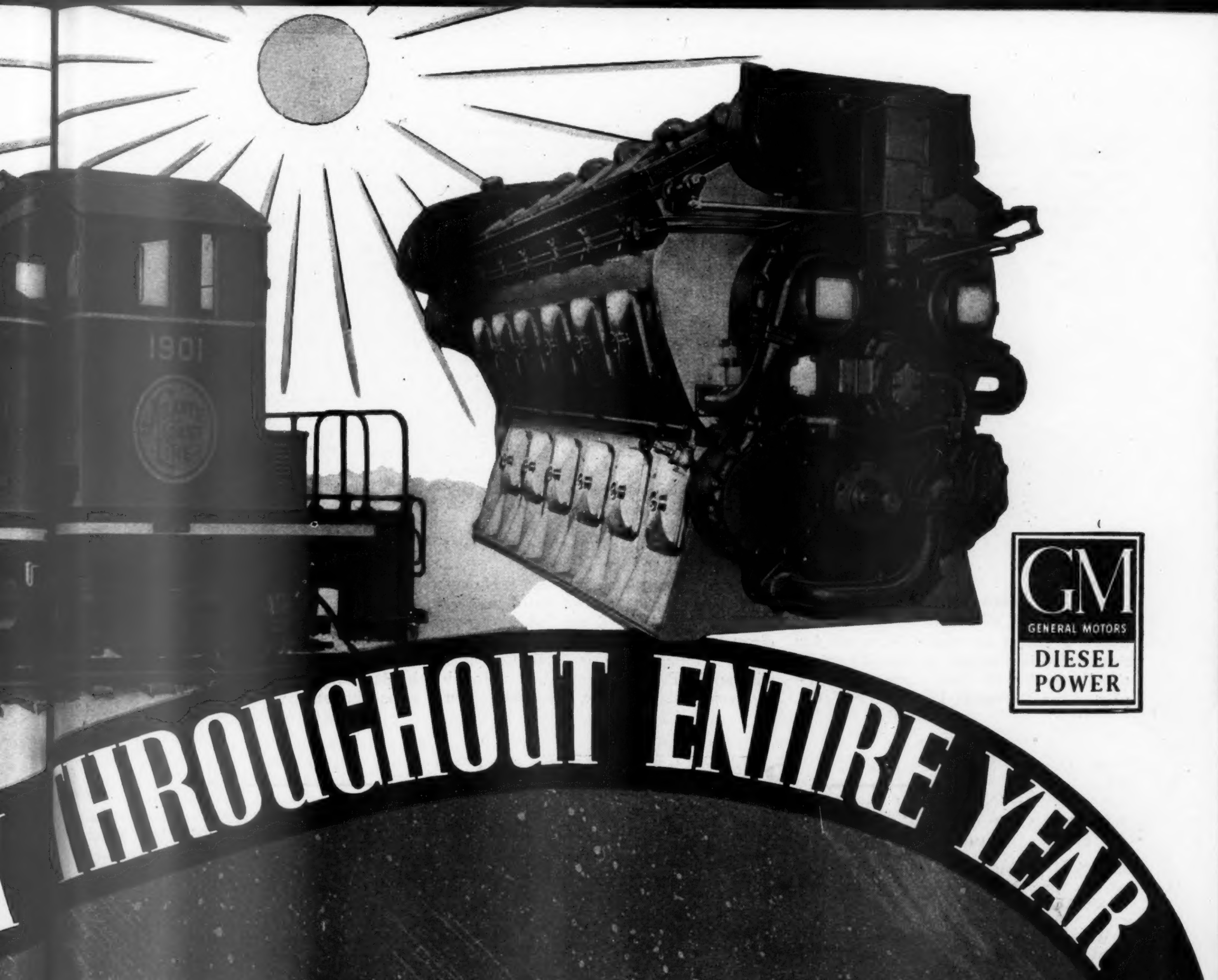

1901
GM
GENERAL MOTORS
DIESEL
POWER
HROUGHOUT ENTIRE YEAR
5312
GREAT NORTHERN
RAILWAY
5312

Mr. Chadwick was graduated from the University of Illinois in 1905, and since that time has been associated with railroad and locomotive building activity. He began his railroad career with the Chicago, Burlington & Quincy at Aurora, Ill., where for three years he engaged in special apprenticeship work. He later entered the employ of the Davenport Locomotive Works

Walter Chadwick

(now the Davenport Besler Corporation) and after 20 years with the company resigned from the position of sales manager to become vice-president of the Clapp-Riley and Hall Equipment Company, Chicago. In 1937, Mr. Chadwick returned to the Davenport Besler Corporation as executive vice-president.

◆

I. N. KIMSEY, salesman in the Akron sales division of The B. F. Goodrich Company, Akron, Ohio, has been appointed manager of that division and R. A. Charlton on the sales staff at Akron, has been appointed assistant manager of the Akron sales division. J. S. Gulledge, in the Akron sales division, has been appointed manager of the St. Louis, Mo., district, and A. M. Fiala, salesman in the Akron sales division, has been appointed product sales manager of the Air-Cell division, devoted to sales of the company's new latex cushioning material.

◆

THE WESTINGHOUSE ELECTRIC & MANUFACTURING Co., at a recent board meeting in New York, elected the following new directors: George A. Blackmore, president of the Westinghouse Air Brake Company, Pittsburgh, Pa., and of the Union Switch & Signal Co., Swissvale, Pa., and Arthur W. Page, a vice-president and director of the American Telephone and Telegraph Co., New York, and a director of the Continental Oil Company.

Obituary

JAMES GLOVER, sales representative of the Scullin Steel Company, St. Louis, Mo., died on December 11, at St. Louis.

◆

CHARLES K. KNICKERBOCKER, first vice-president of the Griffin Wheel Company, died at his home in Chicago on January 7.

◆

HENRY G. DALTON, chairman of the board of the Youngstown Sheet and Tube Co., died on Dec. 27 in a hospital at Cleveland, Ohio, at the age of 77 years.

◆

EDWIN W. ALLEN, vice-president of the General Electric Company, died on January 1, in the Johns Hopkins Hospital, Baltimore, Md. Mr. Allen was 60 years of age at the time of his death.

◆

WALTER C. LEWIS, employed by the National Malleable & Steel Castings Company since 1906, and their sales agent in New York City for the last 19 years, died in Mt. Vernon, N. Y., on December 3, after a long illness.

Personal Mention

General

C. S. MAYS has been appointed fuel agent on the Southern at Knoxville, Tenn., succeeding E. G. Goodwin.

W. V. HINERMAN, master mechanic of the Chesapeake & Ohio, with headquarters at Hinton, W. Va., has been appointed assistant to superintendent motive power. Mr. Hinerman's headquarters will be at Richmond, Va.

C. E. POND, assistant master mechanic of the Radford and Shenandoah divisions of the Norfolk & Western at Roanoke, Va., at Roanoke, Va., has been appointed assistant to the superintendent of motive power, with headquarters at Roanoke. Mr. Pond was graduated in mechanical engineering from the Virginia Polytechnic Institute and entered the service of the Norfolk & Western as a special apprentice in the Roanoke shops in June, 1923. Two months later he was transferred to Portsmouth, Ohio, as shop inspector and served there for two years until August, 1925, when he was promoted to assistant engineer of tests, at Roanoke. In 1928 he was appointed assistant foreman of the frog shop and in January, 1937, assistant foreman of the blacksmith shop, becoming foreman of the latter shop the same year. In 1938 he was promoted to general foreman of foundries, which position he held until June, 1939, when he became assistant master mechanic of the Radford and Shenandoah divisions.

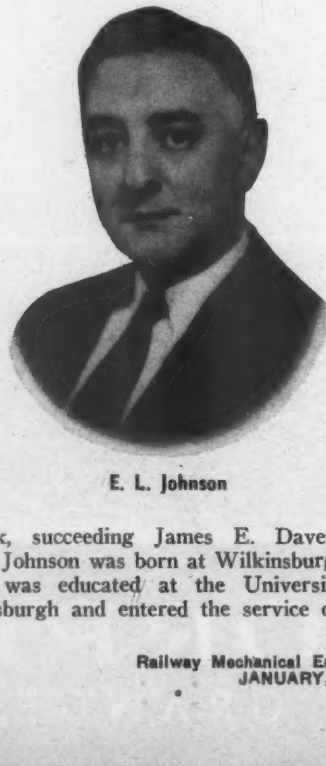
OTTO J. PROTZ, who has been appointed superintendent of the locomotive and car departments of the Chicago & North Western at Chicago as noted in the November issue of the *Railway Mechanical Engineer*, was born on February 23, 1886, at Winona, Minn. He attended public and high schools in Winona until 1902, and on April 9, 1903, entered the employ of the C. & N. W. as a pipe-fitter helper. He then served for four years as a machinist apprentice and,

Karmen-Winger Studios
O. J. Protz

until February 1, 1914, as a machinist. He then became enginehouse foreman at Wyeville, Wis., and on September 1, 1914, was transferred to Huron, S. D., as enginehouse foreman at that point. On October 18, 1920, he was promoted to the position of general foreman, serving until September 18, 1922, at Belle Plains, Iowa; until January 1, 1923, at Huron; and until February 1, 1927, at Chicago shops, locomotive department. He was appointed master mechanic at Winona, Minn., on April 1, 1928, and at Escanaba, Mich., on November 1, 1929. On September 1, 1931, Mr. Protz went to Clinton, Iowa, as assistant master mechanic, and on October 1, 1939, was appointed superintendent of the locomotive and car departments, Chicago shops.

H. A. STEWART, general mechanical inspector of the Fruit Growers Express Company at Alexandria, Va., retired on November 15 after 43 years' service.

E. L. JOHNSON, engineer of tests of the New York Central system, with headquarters at New York, has been appointed assistant chief engineer motive power and rolling stock, with headquarters at New



E. L. Johnson

York, succeeding James E. Davenport. Mr. Johnson was born at Wilkinsburg, Pa. He was educated at the University of Pittsburgh and entered the service of the

New York Central as a special apprentice in July, 1916, at the Beech Grove, Ind., shops. He was appointed assistant engineer of materials and equipment tests early in 1925, having previously served as engineer of service tests. He became engineer of tests early in 1937.

W. F. Collins, assistant engineer of tests of the New York Central, has been appointed engineer of tests, with headquarters at New York, succeeding E. L. Johnson.

Master Mechanics and Road Foremen

P. P. Faulds has been appointed assistant road foreman of engines of the Philadelphia division of the Pennsylvania.

J. Allen Clark, road foreman of engines of the Northern Pacific at Missoula, Mont., has been promoted to master mechanic at Spokane, Wash., replacing L. J. Gallagher.

Paul Thomas, enginehouse foreman of the Pennsylvania at Williamsport, Pa., has been appointed assistant master mechanic, Panhandle division.

M. M. Quinn has been appointed assistant road foreman of engines of the Maryland division of the Pennsylvania, with headquarters at Wilmington, Del.

F. H. Winget, assistant master mechanic on the Cleveland, Cincinnati, Chicago & St. Louis at Bellefontaine, Ohio, has been promoted to master mechanic, with the same headquarters, succeeding J. J. Karibo, who retired on October 1.

C. M. Pettry, general foreman of the Shaffers Crossing shops of the Norfolk & Western, has been appointed assistant master mechanic of the Radford and Shenandoah divisions, with headquarters at Roanoke, Va., succeeding C. E. Pond.

W. H. Powell has been appointed road foreman of engines of the Baltimore & Ohio, with headquarters at Chillicothe, Ohio.

Harvey Smires, assistant road foreman of engines of the Maryland division of the Pennsylvania, has been appointed assistant road foreman of engines, Middle division, with headquarters at Altoona, Pa.

M. G. Stewart, assistant road foreman of engines of the Philadelphia division of the Pennsylvania, has been appointed assistant road foreman of engines, Williamsport division.

Car Department

Cuthbert Steeves has been appointed assistant foreman, freight-car shop, of the Canadian National, with headquarters at Moncton, N. B.

H. A. Bourdeau, general foreman in charge of the locomotive shop and enginehouse of the Canadian National at Riviere du Loup, Que., has had his jurisdiction extended to include car department matters at that point.

Benjamin Bishop, assistant foreman, freight-car shop, of the Canadian National at Moncton, N. B., has been appointed foreman, freight-car shop, with headquarters at Moncton.

Shop and Enginehouse

Dale J. Moses has been appointed locomotive foreman of the New York, Chicago & St. Louis, with headquarters at Conneaut, Ohio.

Robert Mahoney has been appointed foreman, mechanical department, of the New York, Chicago & St. Louis, with headquarters at Conneaut, Ohio.

Martin H. Nelson, general locomotive foreman on the Northern Pacific, with headquarters at Brainerd, Minn., has been appointed acting shop superintendent at that point, succeeding H. E. Bergstrom, who has resigned.

Purchasing and Stores

Thomas E. Savage, assistant purchasing agent of the Erie at Cleveland, Ohio, has been appointed purchasing agent at Cleveland. Mr. Savage was born in 1887, and entered railway service 36 years ago as an office boy in the purchasing department of the Erie. He advanced through various positions in that department and in the fall of 1923 was promoted to assistant to the manager of purchases, with headquarters at New York. On July 16, 1930, he became assistant purchasing agent, with the same headquarters, later being transferred to Cleveland, when the Erie moved its general offices to that point.

Thomas E. Savage

H. O. Wolfe, division storekeeper of the Alton, at Bloomington, Ill., has been appointed assistant to the purchasing agent, with headquarters at Chicago, a newly-created position.

L. V. Foley, assistant division storekeeper of the Alton, has been promoted to the position of storekeeper, with headquarters as before at Bloomington, Ill., succeeding to the duties of H. O. Wolfe.

Obituary

J. H. Schroeder, general foreman car department, Delaware, Lackawanna & Western, with headquarters at Kingsland, N. J., died on November 11 at the Dover (N. J.) General hospital, at the age of 68.

Trade Publications

Copies of trade publications described in the column can be obtained by writing to the manufacturers. State the name and number of the bulletin or catalog desired, when mentioned in the description.

Cranes.—Whiting Corporation, Harvey, Ill. Loose-section catalog descriptive of Whiting cranes for foundries, machine shops, railroad shops, etc.

◆

"An Alco Diesel for Universal Application."— American Locomotive Company, 30 Church street, New York. Booklet illustrating use of Alco engines in railroad and other fields. Ratings between 400 and 1,200 hp., turbocharged (Buchi system) and non-turbocharged, gas or Diesel.

◆

Carboloy. — Carboloy Company, Inc., 11157 East 8 Mile Road, Detroit, Mich. Bulletin GT-120. Discusses fundamentals of cutting steel with carbide tools, with charts giving specific carbide grades to use, recommended starting speeds, tool rakes and clearances, etc.

◆

Hoists.—Coffing Hoist Company, Danville, Ill. Catalog No. G-1. Illustrates and describes Coffing products—hoists, maintenance tools, trolleys, etc.—for use in various fields, including railroad applications.

◆

Arc-Welding Electrodes. — General Electric, Schenectady, N. Y. 40-page illustrated booklet outlining various considerations involved in making proper selection of arc-welding electrodes with a description of characteristics and quality of each type recommended.

◆

Universal Turret Lathes.—Jones & Lamson Machine Company, Springfield, Vt. Three spiralbound booklets with illustrations and general specifications of ram type lathes, Nos. 3, 4 and 5, and saddle type lathes, 7a, 7b, and 7d, and 8a, 8b, and 8d, respectively.

◆

Toncan Iron Pipe.—Republic Steel Corporation, Cleveland, Ohio. Forty-four pages, illustrated. Story of Toncan copper molybdenum iron pipe. Deals with manufacture, rust and corrosion resistance, physical properties, threading procedure, welding, sizes and weights, and outstanding installations and service records in specific fields.

◆

Tool Manual.—Haynes Stellite Company, 205 East Forty-Second street, New York. "Haynes Stellite J-Metal Cutting Tools"—revised edition—brought up-to-date on many phases of cutting-tool practice. Includes a discussion of various tool bit holders and adaptors and describes new Haynes Stellite wear strips for driving and pilot bars. Recommends proper speeds and feeds for use of J-Metal tools in machining many materials under a wide variety of conditions.